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Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 1

REPORT

ON

TURNIP EXPERIMENTS

1903-4

BY

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The following are the analyses of the manures used in these experiments:—

NITRATE OF SODA.

Nitrogen	15·56 per cent.
Equal to Ammonia	18·98 ,,
,, Sodium Nitrate	94·48 ,,

BONE MEAL.

Nitrogen	3·89 per cent.
Equal to Ammonia	4·72 ,,
Phosphates as Tri-basic Phosphate of Lime	52·47 ,,
Equal to Phosphoric Acid	24·04 ,,

Fineness. 0·6 per cent. failed at a sieve of $\frac{1}{10}$ inch mesh.
52·9 per cent. passed a sieve of $\frac{1}{10}$ inch mesh, but failed at a sieve of $\frac{1}{30}$ inch mesh.

SUPERPHOSPHATE.

Soluble Phosphate as Tri-basic Phosphate of Lime	33·51 per cent.
Equal to Phosphoric Acid	15·35 ,,
Insoluble Phosphate as Tri-basic Phosphate of Lime	1·04 ,,

THOMAS' PHOSPHATE POWDER.

Total Phosphate as Tri-basic Phosphate of Lime	31·30 per cent.
Equal to Phosphoric Acid	14·34 ,,

Fineness. 81 per cent. passed a standard sieve (Wagner's).

FLORIDA PHOSPHATE.

Phosphate as Tri-basic Phosphate of Lime	67·92 per cent.
Equal to Phosphoric Acid	31·11 ,,

Fineness. 62·2 per cent. passed a sieve of $\frac{1}{100}$ inch mesh.

SULPHATE OF POTASH.

Potash	48·09 per cent.
Equal to Potassium Sulphate	89·00 ,,

Prices of Manures in Aberdeen, 1903, with 5/- per ton additional for Carriage:—

Nitrate of Soda	£11	0	0	per ton.
Superphosphate	3	5	0	,,
Sulphate of Potash	11	5	0	,,
Bone Meal	6	7	6	,,
Basic Slag	2	12	6	,,
Florida Phosphate	3	15	0	,,
Ground Lime (in bags)	1	12	6	,,

NOTE OF ACKNOWLEDGMENT.

Thanks are due to the occupants of the farms named in the Report, who gave the use of their land, free of charge, for the purposes of the experiments, and who incurred much trouble and some expense in their supervision and execution.

TURNIP EXPERIMENTS.

In the Spring of 1903 the Aberdeenshire County Council granted a sum of money for experimental work in connection with the Department of Agriculture in the University of Aberdeen.

The experiments which form the subject of this Report were carried out with the aid of this grant, and they are dealt with in the following order:—

(*a*) The manuring of the Turnip Crop.

(*b*) The chemical and mechanical analyses of the soils experimented on.

(*c*) The value of certain varieties of turnips judged by cropping power and chemical analyses.

The Season.

The season was decidedly unfavourable to the Turnip Crop in Aberdeenshire owing to the excessive rainfall in the month of May, followed by a drought in June and continuous low temperatures. Want of sunshine throughout the summer and autumn and the abnormal rainfall of October prevented the plants from making up for loss of growth in the early part of the season.

REPORT ON MANURING EXPERIMENT.

Experiments were made in the five centres in Aberdeenshire and one in Kincardineshire named below. As the experiments had to be organised on short notice it was possible to arrange for only six stations, two of which proved unsuitable, partly owing to the soil and partly to the season.

No.	Farm.	Occupier.	Description of Land.	Previous Cropping.
1	Tulloch, Lumphanan	Mr. L. Strachan	Sandy loam on clay subsoil	Oats after lea
2	Wester Fintray, Kintore	Mr. C. Rennie	Deep alluvial loam	Oats after lea
3	Mains of Fedderate, Maud	Mr. D. M. Godsman	Strong loam	Oats after lea
4	Tarves	Mr. J. D. Webster	Fertile gravelly loam	Oats after lea
5	Tipperty, Ellon	Mr. Wm. Gordon	Heavy loam	Oats after lea
6	Mains of Fasque, Fettercairn	Sir John R. Gladstone (per Mr. A. Dewar)	Gravelly loam	Oats after lea

The word experiment does not correctly describe those manurial trials which are intended to demonstrate the effects of certain manures on the Turnip Crop. A demonstration, however, can become a source of agricultural knowledge and a basis for investigation without losing its educational effect. If carried out with care and accuracy it can supply reliable data for the theorist as well as an object lesson to the spectator.

With the double object in view the trials were planned—

1. To test the soils in different districts in order to discover by the actions of the manures which of the essential food constituents were deficient.
2. To compare the relative values of various phosphatic manures.
3. To ascertain the effects of using artificial manures along with Dung.
4. To discover the action of Ground Lime as a crop producer and as a preventive of "finger-and-toe".

There were fourteen plots at each centre; each plot was one-sixteenth of an acre in extent, and the central drills (equal to one-twentieth of an acre) were weighed. The plots were measured, the manures were sown, and the produce was weighed under the superintendance of Mr. W. M. Findlay. All the centres were inspected during the growth of the crops. At Tipperty the seed brairded badly and unevenly and the crop was not weighed on that account. At Tarves the land was in such high condition that the effects of the manures were entirely masked by the accumulated fertility, and so for purposes of comparison Tarves has been left out of the averages, although it is included with the others on Table IX.

What Does the Soil Require?

It is important that every farmer should know what particular ingredient of plant food his soil most requires.

The knowledge that a certain farm is deficient in available Potash, for example, will, or should, modify the system of manuring, and to some extent the system of farming, throughout a rotation.

Every farmer can find out for himself what his soil requires by means of the "Five Plot Test" described below, but few farmers are likely to make the attempt. The field-experimenter is required to provide a short cut to a knowledge of soil requirements, and recent field experiments tend to show that a short cut may become available, for evidence is accumulating that points to an intimate relationship between the surface geology and the effects of the manures. For instance, the soils of the Magnesian

Limestone in one district suffer from Phosphate-hunger, the soils of the Boulder Clay in another district from Potash-hunger, and so on. It is partly with the object of constructing manuring maps that will serve as guides to the system of manuring applicable to various types of soil that the question "What does the soil require" has been asked at each centre. It is obvious that to have any value the answers must be obtained from many centres and over a series of years, and it is hoped that the experiments made this year are only the beginning.

Six plots are devoted to the test of the soil's deficiencies. By leaving out one of the three important ingredients (Nitrogen, Phosphoric Acid and Potash) from each plot in turn and comparing the produce of these plots with the crops obtained by a complete or balanced manure, the soil's wants are clearly indicated.

The average results from four of the stations are stated below :—

TABLE II.

Plot.	Average Results per Acre.								
	Approximate Quantities of Manures per Acre.	Average Yield.		Increase due to Manure.		Cost of Manure.		Profit or Loss.	
		Tons	Cwt.	Tons	Cwt.	s.	d.	s.	d.
1 & 14	No Manure	4	1	...		...		...	
2*	1⅛ cwt. Nitrate of Soda 4½ cwt. Superphosphate ¾ cwt. Sulphate of Potash	12	10½	8	9½	35	4	+49	5
3	1⅛ cwt. Nitrate of Soda 4½ cwt. Superphosphate but **No Potash.**	9	15½	5	14½	27	11	+29	4
4	1⅛ cwt. Nitrate of Soda ¾ cwt. Sulphate of Potash but **No Phosphates.**	5	19¼	1	18¼	20	9	– 1	7
5	4½ cwt. Superphosphate ¾ cwt. Sulphate of Potash but **No Nitrogen.**	11	4¼	7	3¼	23	0	+48	8

* 20 lb. Nitrogen, 80 lb. Phosphoric Acid, 40 lb. Potash — per acre.

Turnips valued at 10/- per ton.

The result is in accordance with general belief as regards the necessities of the Turnip Crop and brings out that Phosphoric Acid is of predominating importance. The importance of Potash, however, as a turnip manure, is not always so clearly indicated. The omission of Potash has reduced the average crop by 55 cwt., while the omission of Nitrogen has resulted in a reduction of 26 cwt. only. In other words, a saving of 8/- worth of Sulphate of Potash has resulted in a loss of 27/- worth of roots, while a saving of 12/- worth of Nitrate of Soda has produced a loss of only 13/- worth of roots.

Averages, however, and especially averages based on so few stations, are apt to be misleading, and an examination of the figures on Table IX. will show that the above result is largely due to the want of available Potash in the soil at Wester Fintray, where a potassic manure is of greater importance than nitrogenous or phosphatic dressings. Apart from Wester Fintray it may be seen that although Potash is more important than Nitrogen on two farms out of the remaining three the difference is only 7 cwt. per acre, and in this connection it should be remembered that the past season, owing to the excessive rainfall, was unsuitable for demonstrating the effect of Nitrate of Soda, especially when it is applied in one dressing as was the case in these experiments. The following notes on the Geology of the farms experimented on have been kindly contributed by Mr. J. S. Grant Wilson of the Scottish Geological Survey :—

Wester Fintray, Kintore. The underlying rock is gneiss with no influence on the surface soil, which is a deep alluvial loam consisting of all sorts of disintegrated rock from the west.

Mains of Fedderate, Maud. The underlying rock is decomposed diorite over land with boulder clay of mixed origin, from 15 to 25 feet deep.

Tarves. The underlying rock is coarse purple gneiss covered with boulder clay of uncertain depth.

Tipperty, Ellon. The underlying rock is the same as at Tarves, but the surface soil which consists of boulder clay is of Forfarshire origin.

Comparative Value of Phosphatic Manures.

The phosphatic manures tested were Superphosphate, Bone Meal, Basic Slag and Ground Mineral Phosphate (Plots 2, 10,

11, 12). The same quantities of Nitrogen, Phosphoric Acid and Potash were applied to all these plots with the exception of plot 10, where the small quantity of Nitrogen in the Bone Meal (in addition to the Nitrogen in the Nitrate of Soda) gave this plot an advantage in that respect, but on the other hand the slower action of the Nitrogen and Phosphates in the Bone Meal placed it practically on an equality with the other plots.

TABLE III.

Phosphatic Manures Compared.

Plot.	Average Results per Acre.								
	Quantities of Manure per Acre.	Average Yield.		Increase due to Manures.		Cost of Manures.		Profit or Loss.	
		Tons	Cwt.	Tons	Cwt.	s.	d.	s.	d.
1 & 14	No Manure	4	1	...		...		...	
2*	1⅛ cwt. Nitrate of Soda 4½ cwt. Superphosphate ¾ cwt. Sulphate of Potash	12	10½	8	9½	35	4	49	5
11	1⅛ cwt. Nitrate of Soda 5 cwt. Basic Slag ¾ cwt. Sulphate of Potash	11	7¾	7	6¾	33	10	39	6
10	1⅛ cwt. Nitrate of Soda 3 cwt. Bone Meal ¾ cwt. Sulphate of Potash	10	3	6	2	39	10	21	2
12	1⅛ cwt. Nitrate of Soda 2¼ cwt. Ground Mineral Phosphate ¾ cwt. Sulphate of Potash	8	9½	4	8½	29	2	15	1

* Plots 2, 11 and 12 received at the rate of 20 lb. Nitrogen, 80 Phosphoric Acid and 40 Potash per Acre. Plot 10 received the above quantities of Phosphoric Acid and Potash, but 13 lb. more Nitrogen.

It will be seen that the average columns give their verdict in favour of Superphosphate, and this verdict is borne out by the individual farms, except Tulloch, where Bone Meal proved slightly superior to the rest as a crop producer, but less valuable than Basic Slag, which produced a crop equal in weight to, and therefore more profitable than, that grown with Superphosphate.

The comparative values of the phosphatic manures are best shown by an estimate of the loss incurred when another manure is used instead of Superphosphate.

Loss incurred by using Basic Slag instead of Superphosphate	9/1
Loss incurred by using Bone Meal instead of Superphosphate	28/3
Loss incurred by using Ground Mineral Phosphate instead of Superphosphate	34/4

There is a common belief that Bone Meal will be more lasting in its effects, and in the end more profitable than Superphosphate. That has yet to be proved. Meantime it starts with a deficit of 28/3 to be made up by the succeeding grain and hay crops.

On the basis of equal weights of Phosphoric Acid, Ground Mineral Phosphate has been unprofitable at these centres. A carefully conducted experiment on the same basis, carried out by the Turriff and Garioch Analytical Association in 1903 on twelve farms, showed the same inferiority of Ground Mineral Phosphate. On the basis of equal money values possibly it would give a better account of itself. It is possible that Bone Meal, Basic Slag and Ground Mineral Phosphate would produce better results if applied earlier, though there is evidence to show that Basic Slag is equally effective when applied in the spring. An experiment is at present being conducted to throw light on this point with regard to all three fertilisers.

Artificial Manures along with Dung.

Is a dressing of artificial manures directly profitable when applied along with Dung to the turnip crop? It has been abundantly proved that large and profitable crops of turnips can be grown by means of artificial manures alone, and centuries of experience have shown that good crops may be grown with Dung alone, but the general practice in turnip-growing districts is to apply artificial manures along with a moderate dressing of Dung, and evidence is accumulating to show that with a moderate dressing of Dung a complete dressing of artificial manures does not prove directly profitable.

Plots 7, 8 and 9 are included in the experiment in order to obtain information on this point and to draw attention to it. Plot 7 received a dressing of 15 tons of Dung per acre, and must be taken as the basis of the test. Representing as it does more than 20 cartloads per acre, 15 tons is perhaps more than the average dressing applied in the North of Scotland, and this should be kept in mind. Plot 8 received 15 tons of Dung also, along with the complete dressing of artificial manures applied to plot 2, and representing the "standard". Plot 9 received half the artificial dressing of plot 8, with the same quantity of Dung. From the statement below it appears that the increase due to the artificial manures is in each case (plots 8 and 9) too small to pay for the manures used. When we examine the results from the individual farms it is seen that the larger dressing of artificial manures resulted in a loss, except at Tulloch where a profit of 20/11 is recorded. The smaller dressing resulted in a loss at every centre.

TABLE IV.

Effects of Artificial Manures along with Dung.

Plot.	Per Acre.				
	Manure.	Average Yield.	Increase due to Artificial Manure.	Cost of Artificial Manure.	Profit or Loss due to Artificial Manure.
		Tons Cwt.	Tons Cwt.	s. d.	s. d.
7	15 tons Dung . . .	13 1½	...	...	...
8	15 tons Dung 1⅛ cwt. Nitrate of Soda 4½ cwt. Superphosphate ¾ cwt. Sulphate of Potash	15 19¼	2 17¾	35 4	−6 5*
9	15 tons Dung 9/16 cwt. Nitrate of Soda 2¼ cwt. Superphosphate ⅜ cwt. Sulphate of Potash	13 17½	16	17 8	−9 8

* The loss is chiefly due to the large quantity of Nitrate of Soda used in order to make Plot 8 comparable with Plot 2—the Standard Plot.

An increase of 35 cwt. of roots was required to pay for the smaller dressing and an increase of 70 cwt. for the larger. The figures below will show how much the crop fell short of the necessary amount.

TABLE V.

Centre.	Increase due to	
	3¼ cwt. Artificials.	6½ cwt. Artificials.
	Tons Cwt.	Tons Cwt.
Mains of Fedderate	1 1	1 17½
Wester Fintray	1 10½	2
Fasque	(decrease) 12½	2 1
Tulloch	4½	5 12½
Increase required to pay for the Artificial Manures	1 15	3 10

These results must, of course, be corroborated. The season was unpropitious, the experiments were few, and only one dressing, and that only in two quantities, was used.

Large *versus* Medium Dressings of Dung.

In few districts will heavy dressings of Dung repay the first cost in the crops to which they are applied, but probably in fewer districts will heavy dressings to the turnip crop fail to give profitable results in the end.

A comparison of plot 6 (20 tons Dung per acre) with plot 7 (15 tons Dung per acre) shows that the average increase due to 5 extra tons of Dung is only 21 cwt., or, if Fasque is omitted from the average, 36 cwt., not nearly enough to pay for the Dung at normal figures, but as the effects of the Dung are long drawn out, and in fact are spread over the entire rotation, to compare 10/- or 18/- worth of increase with the 20/- or 25/- worth of Dung is valueless.

TABLE VI.

Effects of Increasing the Dressing of Dung.

Per Acre.						
Centre.	Plot 7. Increase Due to 15 Tons Dung.		Plot 6. Increase Due to 20 Tons Dung.		Effect of 5 Extra Tons. + or −.	
	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.
Mains of Fedderate . . .	3	15	6	11	+ 2	11
Wester Fintray	9	16½	10	5	+	8½
Fasque	9	10	8	1½	−	8½
Tulloch	13	0	15	9½	+ 2	9½

Rotation experiments alone can determine the relative values of large and small dressings of Dung, and the values of some of the artificial manures also, and this demonstration serves its purpose if it has drawn attention to the importance of, and the necessity for, such experiments. To increase the value of this demonstration, the crops grown on some of the experimental plots in 1904 will be weighed.

It is noticeable that the 5 extra tons of Dung at Fasque have actually decreased the crop, but when the circumstances are taken into consideration, it can be understood. When the Dung was applied and the turnips were sown, the land was exceptionally dry, and the larger quantity of Dung would tend to increase the hurtful effect of the dry seedbed upon the early growth of the young plants by keeping the land unnaturally open. This result of applying a heavy dressing of Dung in the drill in dry weather is not unusual.

The Effects of Ground Lime.

In order to test the practice (not uncommon in the North of Scotland) of applying Ground Lime to the turnip land before, or at the time of, sowing, plot 13 was added to the experiment. This

plot received the same standard artificial mixture as that applied to plot 2, with in addition 10 cwt. of Ground Lime per acre. It was hoped that if "canker" or "finger-and-toe" appeared, the utility or uselessness of the Ground Lime would be shown. On two of the stations the disease appeared, but only on the dunged plots; significant evidence of infection through the Dung.

The manurial effect of the Ground Lime is what was to be expected (see page 24). On Tulloch it has increased the crop by nearly 50 cwt. per acre, but on Wester Fintray it has decreased it from 1 to 2 tons. On the average it has decreased the crop 6 cwt. per acre.

TABLE VII.

EFFECTS OF 10 CWT. GROUND LIME.

Plot.	Per Acre.								
	Approximate Quantity of Manure per Acre.	Average Yield.		Average Decrease due to Lime.		Cost of Manures.		Average Loss due to Lime.	
		Tons	Cwt.	Tons	Cwt.	s.	d.	s.	d.
2	$1\frac{1}{8}$ cwt. Nitrate of Soda $4\frac{1}{2}$ cwt. Superphosphate $\frac{3}{4}$ cwt. Sulphate of Potash	12	$10\frac{1}{2}$	...		35	4	...	
13	$1\frac{1}{8}$ cwt. Nitrate of Soda $4\frac{1}{2}$ cwt. Superphosphate $\frac{3}{4}$ cwt. Sulphate of Potash 10 cwt. Ground Lime	12	$3\frac{3}{4}$		$6\frac{3}{4}$	41	8	10	9

It is noteworthy that Tulloch is the centre at which Basic Slag proved as effective as Superphosphate. It would seem that this land is deficient in lime, and that the Ground Lime supplied the necessary base for the quicker utilisation of the Phosphate. See the following Table:—

TABLE VIII.

Effects of Ground Lime at Tulloch.

Plot.	Manures per Acre.	Produce. Tons	Cwt.
2.	$1\frac{1}{8}$ cwt. Nitrate of Soda $4\frac{1}{2}$ cwt. Superphosphate $\frac{3}{4}$ cwt. Sulphate of Potash	11	$11\frac{3}{4}$
13.	$1\frac{1}{8}$ cwt. Nitrate of Soda $4\frac{1}{2}$ cwt. Superphosphate $\frac{3}{4}$ cwt. Sulphate of Potash 10 cwt. Ground Lime	14	0
	Increase Due to 10 cwt. Ground Lime	2	$8\frac{1}{4}$

Extra Plots at Mains of Fasque.

At Mains of Fasque Mr. Dewar added four plots to the experiment, in order to compare the manures generally used on the farm with the mixtures of the experiment; to test the utility of Sulphate of Ammonia, and to ascertain the effect of a heavy dressing of Ground Lime.

The following Table shows the manures used and the produce obtained :—

Plot.	Manures per Acre.	Weight of Crop. Tons	Cwt.
15	$\frac{2}{7}$ cwt. Sulphate of Ammonia $1\frac{1}{2}$ cwt. Superphosphate 6 cwt. Bone Dust	15	15
16	$1\frac{1}{2}$ cwt. Superphosphate 6 cwt. Bone Dust	14	$7\frac{1}{2}$
17	$\frac{2}{7}$ cwt. Sulphate of Ammonia 6 cwt. Bone Dust	14	$4\frac{1}{2}$
18	$\frac{2}{7}$ cwt. Sulphate of Ammonia $1\frac{1}{2}$ cwt. Superphosphate 6 cwt. Bone Dust 2 tons Ground Lime	10	$12\frac{1}{2}$

A mixture of Sulphate of Ammonia, Superphosphate and Bone Dust (plot 15) has been more effective than any of the combinations used in the experiments. When Sulphate of Ammonia is omitted from the mixture 27 cwt. of roots are lost (compare plots 15 and 16), and when $1\frac{1}{2}$ cwt. of Superphosphate are left out the crop is reduced by 30 cwt.

A remarkable result is the apparent hurtfulness of Ground Lime. Reference to Table IX. will show that in the Departmental experiment 10 cwt. of Ground Lime at Fasque reduced the crop by 2 tons 2 cwt. The additional Plots corroborate this result emphatically.

PLOT.	MANURES PER ACRE.	WEIGHT OF CROP.	
		Tons.	Cwt.
15	$\frac{2}{7}$ cwt. Sulphate of Ammonia $1\frac{1}{2}$ cwt. Superphosphate 6 cwt. Bone Dust	15	15
18	Manures as above, but in addition 2 tons Ground Lime	10	$12\frac{1}{2}$
	Loss of Crop due to Lime	5	$2\frac{1}{2}$

TABLE

Table showing the Kinds and Quantities of Manures applied, the
the Increase resulting from their

Number of Plot.	1		2		3		4		5		6	
Manures Applied per Acre.	No Manure.		$1\frac{1}{8}$ cwt. Nitrate of Soda, $4\frac{1}{2}$ cwt. Superphosphate, $\frac{3}{4}$ cwt. Sulphate of Potash.		$1\frac{1}{8}$ cwt. Nitrate of Soda, $4\frac{1}{2}$ cwt. Superphosphate.		$1\frac{1}{8}$ cwt. Nitrate of Soda, $\frac{3}{4}$ cwt. Sulphate of Potash.		$4\frac{1}{2}$ cwt. Superphosphate, $\frac{3}{4}$ cwt. Sulphate of Potash.		20 tons Dung.	
Name of Farm.	Weight of Roots per acre.		Weight of Roots per acre.		Weight of Roots per Acre.		Weight of Roots per Acre.		Weight of Roots per Acre.		Weight of Roots per Acre.	
	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.
Mains of Fedderate . .	0	9	5	11	4	13	0	10	3	4	7	1
Wester Fintray . . .	12	$17\frac{1}{2}$	22	$0\frac{3}{4}$	14	0	19	$18\frac{3}{4}$	20	$1\frac{1}{2}$	23	$11\frac{1}{4}$
Tulloch	0	8	11	$11\frac{3}{4}$	10	$7\frac{1}{2}$	0	15	11	$6\frac{3}{4}$	15	$16\frac{3}{4}$
Fasque	2	0	10	$18\frac{3}{4}$	10	$1\frac{1}{4}$	2	$13\frac{3}{4}$	10	5	10	$2\frac{1}{2}$
Tarves	25	$3\frac{1}{2}$	26	10.	26	$3\frac{1}{3}$	23	$13\frac{1}{3}$	24	$13\frac{1}{3}$	27	$11\frac{2}{3}$
Average, leaving out Tarves	3	$18\frac{3}{4}$	12	$10\frac{1}{2}$	9	$15\frac{1}{2}$	5	$19\frac{1}{4}$	11	$4\frac{1}{4}$	14	$2\frac{3}{4}$
Increase over the No Manure Plots	...		8	$9\frac{1}{2}$	5	$14\frac{1}{2}$	1	$18\frac{1}{4}$	7	$3\frac{1}{4}$	10	$1\frac{3}{4}$
			S.	D.	S.	D.	S.	D.	S.	D.	S.	D.
Value of Increase . . .	...		84	9	57	3	19	2	71	8	100	10
Cost of Manures . . .	...		35	4	27	11	20	9	23	0	80	0
Profit from the use of the Manures . .	...		49	5	29	4	1	7 (Loss.)	48	8	20	10

IX.

WEIGHT OF PRODUCE OBTAINED ON EACH PLOT, THE COST OF MANURES, APPLICATION AND THE PROFIT PER ACRE.

7	8	9	10	11	12	13	14
15 tons Dung.	15 tons Dung, 1⅛ cwt. Nitrate of Soda, 4½ cwt. Superphosphate, ¾ cwt. Sulphate of Potash.	15 tons Dung, ⅝ cwt. Nitrate of Soda, 2¼ cwt. Superphosphate, 3 stones Sulphate of Potash.	1⅛ cwt. Nitrate of Soda, 3 cwt. Bone Meal, ¾ cwt. Sulphate of Potash.	1⅛ cwt. Nitrate of Soda, 5 cwt. Basic Slag, ¾ cwt. Sulphate of Potash.	1⅛ cwt. Nitrate of Soda, 2¼ cwt. Ground Mineral Phosphate, ¾ cwt. Sulphate of Potash.	10 cwt. Ground Lime, 1⅛ cwt. Nitrate of Soda, 4½ cwt. Superphosphate, ¾ cwt. Sulphate of Potash.	No Manure.
Weight of Roots per Acre.	Weight of Roots per Acre.	Weight of Roots per Acre.	Weight of Roots per Acre.	Weight of Roots per Acre.	Weight of Roots per Acre.	Weight of Roots per Acre.	Weight of Roots per Acre.
Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.
4 5	6 2½	5 6	1 10	4 11	1 13	5 1	0 11
23 2½	25 2½	24 13	20 7½	20 7½	18 3¾	20 17½	13 15
13 7½	19 0	14 12	11 17½	11 11¾	6 16	14 0	0 7
11 11¼	13 12¼	10 18¾	6 16¾	9 1¼	7 5	8 16⅔	2 2½
21 18⅔	27 11⅔	26 4⅙	23 11⅔	26 2⅔	21 1⅔	23 2⅚	27 11⅔
13 1½	15 19¼	13 17½	10 3	11 7¾	8 9½	12 3¾	4 3¾
9 0½	11 18¼	9 16½	6 2	7 6¾	4 8½	8 2¾	...
S. D.	S. D.	S. D.	S. D.	S. D.	S. D.	S. D.	
90 3	119 2	98 3	61 0	73 4	44 3	81 4	...
60 0	95 4	77 8	39 10	33 10	29 2	41 8	...
30 3	23 10	20 7	21 2	39 6	15 1	39 8	...

REPORT ON THE CHEMICAL AND MECHANICAL ANALYSES OF THE SOILS ON WHICH THE EXPERIMENTS WERE MADE.

Much can be learned concerning the requirements and capabilities of soils by their mechanical and chemical analyses. In recent years there has been a revival of interest in soil analysis in this country, and much is at present being done to improve the methods of analysis of soils. In some parts of the country systematic soil surveys are now being undertaken, and typical soils of all varieties of geological origin are being methodically analysed, and the results collected and compared with the results of field experiments and of agricultural experience. We have still much to learn concerning the interpretation of soil analysis, and concerning the means of making it useful to agriculture, and it is only by such systematic examination that we can gain the experience necessary for this purpose. The older methods of soil analysis were very limited in their usefulness, and too much was often expected of them. This led to disappointment. But the methods have now been greatly improved, and are gradually being brought into such relation with agricultural experience that the interpretation of the results of analysis can be relied upon to give true indications of the agricultural value and possibilities of a soil. It was to make a start with such work in the North of Scotland that the analyses of the soils on which the Turnip experiments were carried out were undertaken.

It is unfortunate that we have little precise information concerning the surface geology of the fields from which these soils were derived. The maps of the surface geology of this district are not yet published.

The unpropitious character of the season had a very marked influence on the results of certain of the experiments. This renders it difficult to interpret some of the results without further experience of the same soils under other conditions, which we hope to obtain by continuing the experiments during seasons of a different, and, it is to be hoped, a more favourable kind. It will be shown when the individual results are dealt with below that in certain cases it is very difficult to explain the results of the experiments in the field, in the light of the

analysis of the soil, unless we keep in mind that, in such a season as 1903, the effects of the season often far outweigh all the effects of the manures, and that very exaggerated results are thus obtained, which require to be corrected in the light of results obtained in a season of normal character.

The following Tables give the mechanical and chemical analyses of the soils on which these experiments were carried out. The samples were taken before the soils were manured for the experiment. They were drawn by driving a square iron frame of 6 inch side into the soil to a depth of 9 inches, and taking out the block thus enclosed. Several such blocks were taken from different parts of the area used for experiment. These were mixed together, and the sample for analysis drawn from the mixture. The sample was sent to the Laboratory and air-dried. The mechanical analysis was made in the air-dried material. The chemical analysis, on the other hand, was made in the completely dried fine earth, which passed a sieve with round holes of one millimetre diameter.

TABLE X.

Mechanical Analysis of Soils.

Percentage of Air-dry Soil.

	Tarves.	Wester Fintray.	Mains of Fedderate.	Tulloch, Lumphanan.	Fasque.
Stones (over 3 millimetres)	11·3	3·2	13·4	16·5	17·4
Fine Gravel (over 1 millimetre and under 3)	4·9	5·1	3·7	8·2	5·7
Coarse Organic Matter	0·1	0·3	0·4	0·2	0·2
Fine Earth	83·7	91·4	82·5	75·1	76·7
Composition of Fine Earth.					
Coarse Sand	26·0	42·8	28·9	39·7	25·6
Fine Sand	21·1	13·6	19·7	16·8	14·3
Silt	16·0	10·5	12·1	14·7	26·0
Fine Silt	13·1	7·7	9·1	7·2	11·6
Clay	6·0	3·7	3·8	4·1	6·4
Total loss on Ignition. Organic Matter, Moisture, etc.	13·8	20·0	23·5	14·0	14·4
Carbonate of Lime, etc., dissolved by Dilute Acid (by difference)	4·0	1·7	2·9	3·5	1·7

TABLE XI.

Chemical Analysis of Soils.

Percentages of Dry Fine Earth.

Constituents.		Tarves.	Wester Fintray, Kintore.	Fedderate, Maud.	Tulloch, Lumphanan.	Fasque, Fettercairn.
Loss on Ignition. Organic Matter, etc.		10·02	13·11	16·17	10·00	8·94
Nitrogen		0·306	0·372	0·439	0.326	0·291
Sand and Insoluble Silicates		75·47	77·43	63·40	77·51	77·66
Soluble in Strong Acid.	Phosphoric Acid (P_2O_5)	0·481	0·283	0·367	0·113	0.214
	Potash (K_2O)	0·539	0·244	0·247	0·279	0·463
	Lime (CaO)	0·594	0·593	0·568	0·826	0·759
	Equal to Calcium Carbonate	1·061	1·060	1·015	1·475	1·355
Available Phosphoric Acid		0·107	0·124	0·072	0·046	0·030
Available Potash		0·019	0·012	0.047	0·013	0·012
Available Lime		0·222	0·166	0·183	0·132	0·190
Equal to Calcium Carbonate		0·396	0·296	0·326	0·236	0·339

The mechanical analysis divides the soils into (1) Stones which failed to pass a sieve having round holes of three millimetres diameter. (2) Fine gravel which passed this sieve, but failed to pass one with round holes one millimetre in diameter. (3) Coarse organic matter which failed to pass these sieves, and (4) Fine earth which passed these sieves. The fine earth is further divided into various fine constituents by a sedimentation method. The method followed in this part of the work is substantially that of Mr. A. D. Hall, as given in his book *The Soil*, pp. 48 to 51. The terms used have the same signification as in Mr. Hall's book.

These terms, from Coarse Sand to Clay, express successive degrees of fineness. Coarse Sand is the coarsest grade, and denotes coarse, gritty particles visible to the naked eye, with a diameter varying from about $\frac{1}{25}$th of an inch to $\frac{1}{125}$th of an inch. Clay, on the other hand, denotes particles of the very finest kind.

The particles of Clay are so fine that they will not settle even on standing for twenty-four hours in still water, and they will pass through ordinary filters. The Clay is made up of particles having a diameter less than $\frac{1}{5000}$th of an inch. The other divisions, Fine Sand, Silt and Fine Silt, are intermediate between these extremes. It is on the proportion of particles of different degrees of fineness, quite as much as on its chemical composition, that the value of a soil depends. If the soil is largely composed of very fine particles of Silt and Clay, it becomes so close and tenacious in texture as to be almost impervious to water, and is what is called "heavy" to work. Such a soil may be almost worthless. Even what is called a heavy clay soil, in order to be workable at all, must contain a considerable proportion of the coarser grades of particles. On the other hand, if the soils are largely composed of coarse particles—Sand—they are also of low value, because they cannot retain water, which flows through them too readily, and because they do not yield up nutriment readily to the roots of plants. Good soils are composed of particles of the different grades of fineness in well-balanced proportion. It will be seen from the above table that all these soils are composed of well-mixed materials of all grades of fineness. None of them appears to contain an excessive amount of, on the one hand, Silt or Clay, or, on the other hand, Sand. They are, in fact, all Loamy soils. Not one of them is a really heavy soil, and, on the other hand, not one is too light in texture. So far as mechanical analysis indicates, all of them are useful agricultural soils.

The chemical analysis shows that all the soils are well supplied with organic matter (Humus), and with that most important element Nitrogen, which is contained in the organic matter. The soil from Fedderate, and to a lesser degree that from Fintray, are more than usually rich in Humus and in Nitrogen.

The most important mineral constituents of the soil, Phosphoric Acid, Potash and Lime, are stated (1) in percentages soluble in strong Mineral Acid; (2) in percentages soluble in very weak acid. These latter are known as "available" constituents. The first method of statement—constituents soluble in strong mineral acid—shows the store of these constituents held in the soil. These substances, however, though they may be extracted by the chemist with strong acids, are not necessarily available for the immediate

use of plants. The second method of statement shows the proportions of these constituents which are soluble in a weak solution of the weak vegetable acid, Citric Acid. These constituents are so easily dissolved that it is believed they are available for the use of plants, that is to say, the roots of plants can lay hold of and make use of them. They are therefore commonly called "available" constituents. It is the percentages of these "available" mineral constituents that are important in forming a judgment of the state of fertility of the soil, and of the probable need of Phosphoric Acid, Potash or Lime, as the case may be, in the manure. The analyses indicate that all of these soils are well supplied with available Phosphate. Certain of them, Tarves and Wester Fintray, are exceptionally rich in this constituent. Some of these results are so surprising when compared with the results obtained in the manuring experiments, that exceptional care was taken in confirming them. We were not surprised to find that the soil at Tarves was exceptionally rich in available Phosphate, or, indeed, in any other constituent required by plants. Neither is it surprising to find that Wester Fintray contains plenty of available Phosphoric Acid, as the experiment there showed that the crop is very little benefited by phosphatic manures. In other words, the soil there is itself able to supply the crop with plenty of Phosphoric Acid. But in the cases of Tulloch, Mains of Fedderate and Fasque the results are very surprising. The analyses indicate that the soils are all well supplied with available Phosphoric Acid, but the results of the experiments show that without Phosphoric Acid in some form in the manure practically no crop is obtained; while with phosphatic manure in the cases of Tulloch and Fasque a moderate crop is obtained, and in the case of Mains of Fedderate a small crop is obtained. That the season was an exceptional one is shown by the small crops obtained on these farms, and especially on Mains of Fedderate, no matter what manuring was given. But after every allowance is made for season, the results are still abnormal, and we can only wait for more information obtained from further experiments before attempting to explain them fully.

In the case of Potash the results are more easily explainable. Mains of Fedderate is the only soil which is rich in available Potash, the others are all only moderately well supplied. On the

other hand, none of them shows what would be considered great poverty in available Potash. Wester Fintray is one of those with least available Potash, and a large crop was obtained on this soil whenever an all-round manuring was given. But whenever Potash was omitted from the manure the crop was very seriously reduced. See, for instance, the crop returns given by plots 2 and 3 which got the same manuring, except that Potash was omitted in plot 3. On plot 3 the soil, when supplied with Phosphate and Nitrogen, is able to supply the crop with enough Potash for a moderate crop of fourteen tons, but where available Potash is applied in the manure on plot 2, the crop is raised to twenty-two tons. This is a good example of the necessity for plenty of available Potash if a large crop is to be grown. In the Tulloch and Fasque soils the available Potash is about equal to that found in the Wester Fintray soil, but as the total crop grown on these farms was much smaller than that grown at Wester Fintray, the diminution of crop on plot 3, where Potash is not applied, though quite distinct, is not so great as in the case of Wester Fintray. In other words, these soils were able to supply sufficient Potash for the very moderate crops grown last season. At Mains of Fedderate the whole crop is very small whatever the manuring, and the richness of the soil in Potash has little room for action, as it is quite masked by the overwhelming poverty of result caused by the season.

These analyses seem to indicate that our local soils are much better supplied with available Phosphoric Acid than with available Potash. Probably, in the case of all these soils, they have been much more heavily manured for many years back with Phosphatic than with Potassic Manures.

All five soils are moderately well supplied with Lime and with available Lime. It is very unusual in this part of Scotland to find soils rich in Carbonate of Lime. Many soils contain a fair amount of Lime in other forms of combination, forms in which the Lime is soluble only after more drastic treatment than that which is necessary to dissolve Carbonate of Lime. The Tulloch and Fasque soils are examples of this. Though Tulloch is the soil richest in Lime, soluble in strong acid, it is the poorest in available Lime, and the manuring experiment shows that it is directly benefited by the application of Lime. The results of plot 13, as compared with plot 2 (see page 13), show that it

is the only soil which gives a direct increase in crop for the application of Lime. In all the other cases the application of Lime causes a diminution of crop. Nevertheless, all these are soils which will probably be benefited by the application of dressings of Lime from time to time. The reason why the Lime causes diminution of the crop in most cases is that it was applied at the wrong time. In order to benefit the Turnip Crop, Lime should be applied at least some months before the land is drilled, and should be worked thoroughly into the soil during its cultivation. The common practice with farmers, in this part of the country at least, is to apply Lime at the same time as other Artificial Manures, that is, with the Seed. So far as the Turnip Crop is concerned, this is a mistake. The Lime so applied will probably do good in subsequent years, but, except in cases, such as that of the soil at Tulloch, where Lime was urgently wanted, the probability is that little good will be done to the Turnip Crop, and the use of Lime may, as has been the case in four of these experiments, be followed by an actual diminution of the crop. It is to be remembered that the action of Lime is not like the action of Nitrogenous, Phosphatic and Potassic Manures. These are needed mainly for the direct nourishment of the plant. Lime has much more complicated functions to fulfil. Its main use is not to directly feed the plant. It is more largely needed to keep the soil in proper condition, and to enable it to render up its stores of Nitrogen in condition fit for the use of crops. So long as the Lime present in the soil is sufficient for the proper performance of these indirect services to the crop, there will be abundance present for its direct consumption. The main action of Lime on the crop is slow and long drawn out, and in order to benefit any crop, the Lime should be applied, if possible, before the Seed and worked into the land. In the case of these experiments, they were arranged so late that it was impossible to apply the Lime at what we considered the proper time. We therefore decided that the next best thing would be to apply the Lime at what we considered an improper time, but the time at which it is applied by many farmers. This we have done, and the result has been precisely what was to be expected.

The fact that Lime was needed on the Tulloch soil more than on any of the others is further illustrated on plots 10 and 11,

which received Bone Meal and Basic Slag respectively, instead of Superphosphate. Superphosphate is an acid manure which draws upon and helps to use up the available Lime of the soil. On the other hand, Bone Meal and Basic Slag are manures which supply a little Lime to the soil. On the average, Superphosphate is the most active, and therefore, for the weight of Phosphoric Acid applied, the most effective phosphatic manure. This is well illustrated in the average of these experiments. Tulloch is the sole exception from the rule that plot 2, which received Superphosphate, gives a bigger crop than plots 10 and 11, which received the Bone Meal and Basic Slag. The most obvious explanation of this exception is that the Tulloch soil was especially in need of Lime, and that Superphosphate not only did not supply it with Lime, but caused a drain on its Lime; the Bone Meal and Basic Slag, on the contrary, helped to supply it with the Lime it needed. The Bone Meal and Slag are not any more effective as phosphatic manures here than elsewhere, but the small amount of Lime which they supply turned the balance in their favour in this particular case.

One of us has occasion to thank very warmly Mr. Profeit, B.Sc., and Mr. Davie, B.Sc., both late students of the Agricultural Department, for the help which they gave in carrying out the the analyses of soils and manures required in the course of these experiments.

REPORT ON THE CROPPING POWER OF DIFFERENT VARIETIES OF TURNIPS.

Nearly 150,000 acres of turnips and swedes are grown yearly in the four counties contiguous to Aberdeen, and in this area almost every variety of turnip and swede in Great Britain is probably represented.

To test them all is impossible, but under many names there are comparatively few types distinct in shape, colour and constitution. The commonest swede in any locality is the Purple Top Globe or Oval, to which class the Imperial and Best of All belong. Next in favour comes the Bronze Top, of varying shapes, but generally reckoned a hardier kind and a better keeper than the Purple Top. Lastly, the Green Top, usually smallest in acreage, hardy and full of substance, but sometimes a comparatively small cropper. The following seven varieties of swedes were selected for the test. They represent all three types, and include varieties from several districts of Scotland and England, as well as some known locally.

Purple Top Globe or Oval Swedes.	
Inverquhomery	Reid & Leys.
Smith's Prize Purple Top . .	Smith & Sons.
Extra Improved	Drummond, Stirling.
Best of All	Dickson, Brown & Tait.
Imperial	Webb.
Bronze Top Globe.	
Fell's Bronze Top . . .	Fell, Hexham.
Green Top.	
Kinaldie.	

Of yellows, which are grown more extensively in the neighbourhood of Aberdeen than anywhere else in the country, there are also at least three types popular locally: the Purple Top Yellow, a heavy cropper, but apt to be watery and soft; the Green Top, hardier and firmer, and the Old Meldrum, a close-grained solid root, the survivor of many hard winters.

The following five varieties of yellow turnip were chosen, containing the three types, as well as two softer kinds from the South.

Sittyton Purple Top . . .	Messrs. Smith & Sons.
Challenger Green Top . .	,,
Old Meldrum.	
Invincible	Messrs. Webb.
Centenary	Messrs. Sutton.

The twelve varieties were grown at eight centres, but at one farm (Haddo House) the ravages of game so spoiled the crop that no samples were taken. The remaining farms were :—

Bridgend, Port Errol	Mr. Cantlay .	Peaty loam over gravel . . .	After oats
Culter-Cullen, Udny .	Mr. T. H. Gibson	Cold clay over clay	,,
Tochineal, Cullen .	Mr. Bruce . .	Deep loam inclined to clay . .	,,
Meikle Endovie, Alford	Mr. G. F. Barron	Thin loam on clay subsoil . .	,,
Newton, Insch . .	Mr. A. M. Gordon	Deep fertile loam .	,,
Learney, Torphins .	Lieut.-Col. Innes	Medium loam . .	,,
Home Farm, Strichen	Mr. J. Sleigh .	Gravelly loam . .	,,

Each variety was grown in duplicate at each centre, except at Learney and Culter-Cullen, and the duplicates were an equal distance apart. The ordinary dressing of farm-yard manure was applied along with artificial manures at the rate of 5 cwt. Superphosphate and $\frac{3}{4}$ cwt. Sulphate of Ammonia, per acre. The seed was sown at the usual time, and all varieties received similar treatment at each farm, but it was impossible to deal in the laboratory with so many samples at one time, and so the weights and samples were taken at intervals of about a week.

Dates when samples were taken and weights of crop estimated :—

Bridgend . . .	10th December, 1903.
Culter Cullen . .	17th ,, ,,
Tochineal . . .	23rd ,, ,,
Meikle Endovie . .	4th January, 1904.
Newton . . .	11th ,, ,,
Learney . . .	18th ,, ,,
Strichen . . .	25th ,, ,,

A similar area was weighed and sampled throughout, making 144 weighings and 144 sets of samples.

The Table below shows the average yield of roots calculated from the duplicates of each variety at each farm.

TABLE I.

Average Yield of each Variety at each Centre.

	Bridgend.		Culter-Cullen.		Tochineal.		Meikle Endovie.		Newton.		Learney.		Strichen.		Average.	
Yellows.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.
Sittyton Purple Top	35	18	14	14	27	3	23	10	26	3½	19	0	25	8	24	11
Centenary	38	13½	18	2	28	18½	21	1½	20	5	21	7	18	0	23	15
Old Meldrum	33	10½	13	10	22	9	22	11½	18	18	20	3½	19	3	21	9
Invincible	33	14	14	6	23	18½	20	0	17	19½	20	3½	19	18	21	7
Challenger	32	12½	6	1	24	19	18	0	19	8	19	0	19	15	19	19
Swedes.																
Inverquhomery	29	17½	4	16	23	19	15	18½	20	4	18	18	14	0	18	2
Best of All	28	9½	4	7	21	16½	16	0	21	12½	17	10	13	6	17	11½
Smith's Purple Top	27	8½	7	3	22	19	15	7	18	3	12	12	13	6	16	14
Kinaldie	24	18	5	3	20	9½	14	17	18	0	18	4	12	6	16	6¾
Drummond's Extra Improved	26	4	5	3	21	16½	14	4	18	7½	17	10	9	15	16	3
Fell's Bronze Top	28	3½	3	9	21	9½	12	4½	17	1	14	6	10	17	16	0
Webb's Imperial	25	1½	9	9	21	8½	15	3	16	2½	16	2	7	11	15	17

REPORT ON THE COMPOSITION OF DIFFERENT VARIETIES OF TURNIPS.

It is well-known that turnips vary very much in composition. They vary according to season, soil, manuring, climate and variety. Not only so, but it has been found that individual bulbs of the same variety, grown alongside one another, under the same conditions of soil, manuring, etc., vary widely in composition. While this is so, it has been found that an average composition can be determined for any variety by taking the average analysis of a large number of samples, and that certain varieties are, on the average, better than others.

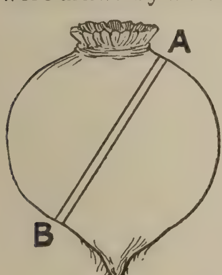
The object of these experiments is to determine the average composition of the different varieties of yellow and swedish turnips, grown as already described in this paper. Hitherto little or no attempt has been made to improve the composition of turnips by selecting parent plants for seed by analysis. The sugar beet has been enormously improved in a comparatively short space of time by this method. The turnip varies very greatly in composition, and, no doubt, by selecting as bulbs from which seed is to be grown, only those which have been found by analysis to be of good composition, in a few years strains of turnips could be produced of greatly improved composition. As a preliminary to entering on work of this kind, which will require a very great deal of time and labour, it is advisable to gain as much information as possible about the composition and variations of existing varieties. The series of analyses recorded here are intended as a small contribution to this work, and it is also hoped that they will be useful to farmers in showing which yellows and swedes produce bulbs of the best composition, and give the greatest amount of food per acre.

Five varieties of yellows and seven varieties of swedes were grown in these experiments on seven different farms. On nearly every farm the plots were in duplicate, and samples were taken from every plot. That is to say, twenty-four samples were received from most of the farms. In addition a large number of

varieties grown on the small plots at the Botanic Gardens were analysed. There were a very large number of samples to be dealt with, and these had to be undertaken in a comparatively short space of time. It was, therefore, necessary to use methods of analysis as rapid as was consistent with the necessary accuracy. There was little time for doing preliminary work to determine suitable methods of analysis, and for this first season we drew upon the experience of others who have been working in this field, and based our methods of analysis largely upon theirs. Mr. T. B. Wood, Reader in Agricultural Chemistry, Cambridge University, and Mr. Collins, Lecturer in Agricultural Chemistry, Durham College of Science, Newcastle-upon-Tyne, who have both been engaged for some years past in investigations into the composition of mangels and turnips, have published their methods of analysis and results in the reports of their respective departments and elsewhere. I have to acknowledge my indebtedness to Messrs. Wood and Collins for many hints.

Method of Sampling.

In order to arrive at the average composition of any plot it was considered necessary to sample at least 100 bulbs. The samples were drawn by an auger. The auger was driven through the centre of the bulb slantwise from the shoulder to beside the tail, as shown in the diagram.



There are reasons for doubting whether this is the best method of drawing the sample, and we hope to make some further experiments on this point before another season. Samples drawn by others in experiments on the composition of roots have usually been taken by selecting by eye from the field or from a heap what were considered average bulbs. Previous experience, which one of us had during certain turnip experiments, made in connection with the Agricultural Department of the Glasgow and West of Scotland Technical College,* led us

* "Experiments in the Composition of Turnips," by James Hendrick, *Journ. Soc. Chemical Industry*, vol. xvi., p. 213.

to believe that this is a faulty method of drawing samples. The eye is apt to be deceived and to select bulbs which are above the average in size. In order to get as fair a sample as possible, we took 100 bulbs just as they came in the drill. Two points were chosen in the plot, and at each of these the sampler went along the drill and bored 50 bulbs—large or small, just as they came. The samples were at once wrapped up in grease-proof paper, and, as soon as possible, despatched to the laboratory.

Methods of Analysis.

The sets of 100 cores were ground up in a small mincing machine which reduced them to a uniform pulp. This pulp was well mixed, and samples at once weighed out for the determination of dry matter and of sugar. Though at first sight this method seems very simple, and appears to secure a fair sample, certain practical difficulties were soon found. It was found difficult to get duplicate results—all the analyses were made in duplicate—to agree well in moisture, especially in the case of the softer varieties. The liquid appeared to drain away from the solid part of pulp so readily that even though mixing was continued all the time it was found very difficult to keep the mass uniform. This method will probably be modified in any further experiments.

The dry matter was determined by drying the pulp till constant in aluminium dishes, in an air oven kept at a temperature of about 60° C.

The determination of dry matter in a root, though it tells us the amount of solid food which it contains, is not sufficient to completely indicate its feeding value. The value depends on the nature as well as on the amount of the solid constituents. As it would be practically impossible to make a complete analysis of the dry matter of each sample in an investigation of this kind, on account of the great amount of labour involved, it is usual to determine only the sugar. Sugar is the most important solid constituent of all the root crops, and it has generally been held that the amount of sugar present, taken along with the total amount of dry matter, indicates sufficiently the quality of the root. Most of the experiments, however, made upon this point have been made on beets or mangels. The sugar in beets or

mangels is quite different from the sugar in turnips. In beets we have sucrose or cane sugar, in turnips a mixture of dextrose or grape sugar with levulose and other sugars. For chemical reasons it is much more difficult to determine the sugar in turnips than it is in beets or mangels. Also the determination when made is of less value, and we have much doubt whether the determination of the sugar in the ordinary manner casts much light on the feeding value of the root. This is a point in which further experiment is needed, and we hope to return to it in the future.

After trying the methods used by Mr. Wood and by Mr. Collins in their work on swedes, we came to the conclusion that the Soldiani process used by Mr. Wood[1] is the more suitable and trustworthy. This process was therefore used for all our sugar determinations. Unlike Mr. Wood's, however, our determinations were not made in the juice, except in the cases of a few duplicates, but the turnip pulp was weighed out and the sugar calculated directly to percentage of the total crop. The percentage of sugar is calculated as if it were invert sugar.

Results of the Analyses.

The results of the analyses of the yellows and swedes grown on seven farms are shown in Table II. The table also gives the average amount of dry matter and sugar for each variety, and the average of all the varieties of yellows and of swedes respectively for each farm. The varieties are arranged in order of the average amount of dry matter which they contained. Those which contained the highest amount of dry matter are placed first.

As the table shows, the grand average of all the yellows in dry matter is only 8·77 per cent. That is, out of a 20-ton crop of yellows, on the average only 1 ton 15 cwt. consists of dry feeding material. The rest consists of water. This is not a very high average amount of dry matter, and should be capable of considerable improvement. When we look at the range of variation of the varieties we find it is very wide. The highest individual figure

[1] *Proceedings of the Cambridge Philosophical Society*, vol. xii., pt. ii., p. 97.

TABLE II.

AMOUNT OF DRY MATTER AND SUGAR IN YELLOW TURNIPS AND SWEDES. EXPRESSED IN PER CENT.

		Bridgend.	Culter-Cullen.	Tochineal.	Meikle Endovie.	Newton.	Learney.	Strichen.	Average.
Yellows.									
Old Meldrum	Solids	9·01	10·31	10·26	8·95	9·74	10·09	8·58	9·56
	Sugar	3·53	4·66	4·64	4·64	4·05	3·87	3·58	4·14
Challenger	Solids	8·78	11·10	10·11	9·42	8·45	9·56	8·25	9·38
	Sugar	3·96	4·65	4·90	4·82	4·00	4·04	4·27	4·38
Sittyton Purple Top	Solids	8·18	9·62	9·66	9·60	7·58	8·83	8·88	8·91
	Sugar	3·22	4·14	4·94	4·27	3·72	3·95	4·41	4·09
Webb's Invincible	Solids	8·60	9·86	9·29	9·52	7·48	8·88	8·34	8·71
	Sugar	3·63	4·11	4·83	4·81	3·96	4·10	4·57	4·28
Centenary	Solids	6·73	7·98	8·25	7·96	4·84	7·74	7·47	7·28
	Sugar	2·40	3·68	3·94	3·63	2·84	3·50	3·55	3·36
Average	Solids	8·26	9·77	9·51	8·89	7·62	9·02	8·30	8·77
	Sugar	3·35	4·25	4·65	4·43	3·71	3·89	4·08	4·05
Swedes.									
Kinaldie Green Top	Solids	11·92	12·15	11·16	10·30	?	10·62	9·37	10·92
	Sugar	5·22	5·01	5·95	4·76	4·31	5·20	5·44	5·13
Smith's Purple Top	Solids	11·56	13·04	10·00	9·35	9·48	11·58	9·00	10·57
	Sugar	5·49	5·61	5·66	4·46	5·08	5·25	4·93	5·21
Fell's Bronze Top	Solids	11·83	11·95	10·10	8·84	10·04	10·52	9·38	10·38
	Sugar	5·60	5·30	5·65	4·53	4·85	4·73	5·19	5·12
Webb's Imperial	Solids	11·47	11·44	10·59	8·53	9·35	10·97	9·31	10·24
	Sugar	5·45	4·95	5·68	4·56	4·86	4·71	5·74	5·13
Inverquhomery	Solids	11·15	11·38	9·80	8·65	9·37	10·72	9·54	10·09
	Sugar	4·95	5·39	5·75	4·33	4·36	4·86	5·26	4·99
Best of All	Solids	10·65	10·66	10·40	8·58	9·51	9·65	9·41	9·84
	Sugar	5·29	5·48	5·69	4·84	5·03	5·01	5·27	5·23
Drummond's Extra Improved	Solids	11·32	10·77	10·43	9·08	8·01	9·63	9·05	9·76
	Sugar	5·07	5·66	5·49	4·59	4·18	5·07	4·99	5·01
Average	Solids	11·41	11·63	10·35	9·05	9·29	10·53	9·29	10·26
	Sugar	5·30	5·34	5·70	4·58	4·67	4·98	5·26	5·12

is given by Challenger, which at Culter-Cullen had over 11 per cent. of dry matter, while the lowest is given by Centenary, which at Newton contained less that 5 per cent. of dry matter, or less than 1 cwt. of dry matter in the ton of turnips. On every farm Centenary was decidedly the poorest in both dry matter and sugar. It is a very soft, watery turnip, and when pulped in the mincing machine flowed out in an almost liquid state. On the other hand, Old Meldrum and Challenger are above the average in quality.

In the swedes the grand average for all the varieties and farms is 10·26 per cent. of dry matter. Though this is not a very high figure it is a considerable improvement on the average of the yellows. The variation between the varieties is not so great as in the case of the yellows. The whole difference in average composition between the highest and the lowest is only a little over 1 per cent. There is no outstanding variety either for goodness or badness, but the varieties follow closely after one another in quality. There are considerable differences between individual samples, both according to variety and according to the farm on which they were grown. It will be noticed that certain farms give, on the whole, better quality than others. Culter-Cullen, where the crops, especially swedes, were small, is first, both in yellows and swedes, in average percentage of dry matter. At Bridgend, where the crops, both of yellows and swedes, were large, the swedes are above the average in dry matter while the yellows are below the average. This result is quite consistent all through, for every variety of swedes is considerably richer than the average, while every variety of yellows is a little poorer than the average. At Newton, on the other hand, both yellows and swedes are of poor composition. With only one exception, Old Meldrum, every variety, both of yellow turnip and of swede, is distinctly below the average in composition. Explanations of these facts need to be sought in the soil, climate, or some other external condition, as the variety of seed and the manuring was the same in all cases.

The percentages of sugar found do not appear to bear any definite relation to the percentages of dry matter. The variations between sugar and dry matter are somewhat irregular. On the average, half the dry matter in the swedes, and rather less than

half the dry matter in the yellows, consists of sugar. If we except the case of Centenary, which is so very much poorer than all the others that it occupies a class by itself, it will be found that both in the case of yellows and of swedes the differences in percentage of sugar between different varieties grown on the same farm are comparatively small. Generally speaking, they appear to be smaller than the differences between the amount of sugar found in the same variety grown on different farms.

The determination of the sugar in turnips, if it is to be of use in experiments of this kind, should indicate the quality of the dry matter. It has been determined that the root contains a certain amount of dry matter. That is a valuable index as to the feeding quality of the root. But we wish to know something further. We wish to know something of the feeding quality of this dry matter. It may consist in some cases largely of materials of high feeding value, and in others of more fibrous materials of lower value. We require something which will indicate to us this higher or lower value of the dry matter. The determination of the sugar as made in these experiments is not only more troublesome than the determination of the dry matter itself, but does not appear to supply a very satisfactory index, and in future experiments we hope to look for a better one.

Yields of Dry Matter per Acre.

In order to find which crops are really yielding the greatest amounts of dry food per acre, we must combine together the yields per acre given in Table I. and the percentages of dry matter given in Table II., and calculate the yields of dry matter per acre given by the different varieties. These are given in Table III. In this table the varieties are arranged in order of merit. The order of merit here given is a much truer one than one based merely on total weight of crop per acre, or one based merely on the composition of the turnips. This is shown in Table IV. which compares the varieties as "crop producers" and as "food producers". Centenary, which in yield of crop is almost at the top of the yellows, is worst in yield of dry matter per acre, which shows that in spite of its great weight-producing capacity

TABLE III.

Dry Matter per Acre Yielded by the Different Varieties.

		Bridgend.			Culter-Cullen.			Tochineal.			Meikle Endovie.			Newton.			Learney.			Strichen.			Average.		
		Tons	Cwt.	Lb.	Tons	Cwt.	Lb.	Tons	Cwt.	Lb.	Tons	Cwt.	Lb.	Tons	Cwt.	Lb.	Tons	Cwt.	Lb.	Tons	Cwt.	Lb.	Tons	Cwt.	Lb.
Yellows.																									
Sittyton Purple Top	Dry Matter.	2	18	81	1	8	31	2	12	50	2	5	13	1	19	76	1	13	61	2	5	11	2	3	30
Old Meldrum . .	,,	3	0	44	1	7	93	2	6	6	2	0	44	1	16	90	2	0	79	1	2	96	1	19	32
Webb's Invincible .	,,	2	17	107	1	8	20	2	4	49	1	18	9	1	6	100	1	15	93	1	13	21	1	17	89
Challenger . .	,,	2	17	31	0	13	48	2	10	48	1	13	102	1	12	87	1	16	42	1	12	65	1	16	76
Centenary . .	,,	2	12	5	1	8	98	2	7	80	1	13	60	0	19	67	1	13	4	1	6	100	1	14	59
Average (Yellows) .	,,	2	17	31	1	5	35	2	8	24	1	18	23	1	11	17	1	15	100	1	12	14	1	18	35
Swedes.																									
Inverquhomery .	,,	3	6	69	0	10	103	2	6	105	1	7	61	1	17	95	2	0	58	1	6	79	1	16	81
Kinaldie Green Top	,,	2	19	40	0	12	57	2	5	78	1	10	66		—		1	18	72	1	3	5	1	14	109
Smith's Purple Top	,,	3	3	40	0	18	70	2	5	100	1	8	78	1	14	46	1	9	20	1	3	105	1	14	97
Best of All . .	,,	3	0	73	0	9	30	2	5	43	1	7	50	2	1	14	1	13	86	1	5	2	1	14	74
Webb's Imperial .	,,	2	17	57	1	1	69	2	5	41	1	5	94	1	10	17	1	15	35	0	14	5	1	12	93
Fell's Bronze Top .	,,	3	6	74	0	8	27	2	3	41	1	1	68	1	14	26	1	10	9	1	0	39	1	12	0
Drummond's Extra Improved . .	,,	2	19	35	0	11	10	2	5	59	1	5	84	1	9	48	1	13	78	0	17	72	1	11	79
Average (Swedes) .	,,	3	1	103	0	13	20	2	5	42	1	6	88	1	14	50	1	14	51	1	1	60	1	13	108

TABLE IV.

Varieties Arranged in Order of Yield of Crop.	Tons.	Cwt.	Varieties Arranged in Order of Yield of Dry Matter.	Tons.	Cwt.	Lb.
Yellows.						
Sittyton Purple Top	24	11	Sittyton Purple Top	2	3	30
Centenary . .	23	15	Old Meldrum . .	1	19	32
Old Meldrum . .	21	9	Webb's Invincible .	1	17	89
Webb's Invincible .	21	7	Challenger . .	1	16	76
Challenger . .	19	19	Centenary . .	1	14	59
Swedes.						
Inverquhomery .	18	2	Inverquhomery .	1	16	81
Best of All . .	17	11½	Kinaldie Green Top	1	14	109
Smith's Purple Top	16	14	Smith's Purple Top	1	14	97
Kinaldie . . .	16	6¾	Best of All . .	1	14	74
Drummond's Extra Improved . .	16	3	Webb's Imperial .	1	12	93
Fell's Bronze Top .	16	0	Fell's Bronze Top .	1	12	0
Webb's Imperial .	15	17	Drummond's Extra Improved . .	1	11	79

it really yields only a small crop of food per acre. On the other hand, Sittyton Purple Top, which is first in yield of crop per acre, is also easily first in yield of dry food per acre. Though it is only 3½ per cent. ahead of Centenary in cropping power, it is 26 per cent. ahead in production of food per acre.

Among the swedes similar changes in position are found according as the varieties are judged by the weight of crop given in Table I., or by the weight of dry matter per acre yielded as shown in Table III. Inverquhomery leads on both lists, but Best of All and Drummond's Extra Improved move down, and Kinaldie and Webb's Imperial move up in Table III. It will be noticed that though they contain a smaller percentage of dry matter, the yellows, on account of their greater cropping powers give, on the average, a considerably greater amount of dry food per acre than the swedes.

It is often supposed that the turnip crop gives a very big yield of food per acre as compared with other crops. Table III. will help to correct this illusion which is due to the great weight of the crop removed from the field. Only one variety, Sittyton Purple Top, gives an average dry crop of over two tons per acre. The grand average for all the yellows is only a little over 38 cwt., and for all the swedes a little under 34 cwt. A fair crop of oats,

grain and straw together, or of hay, first crop and aftermath, will easily give an amount of dry matter per acre equal to this.

The average amounts of dry matter yielded by the different farms vary much more, especially in the swedes, than those yielded by the different varieties. Bridgend leads both in swedes and yellows. In swedes it yields the fine average of over 61 cwt. of dry matter per acre, while in yellows it yields over 57 cwt. per acre. On the other hand, Culter-Cullen, though it was first in percentage of dry matter both in yellows and swedes, is last in the amount of dry matter per acre, on account of the miserable crops obtained on this cold stiff clay soil.

Composition of Roots Grown in the Botanic Gardens.

A large number of varieties of turnips and swedes and two varieties of mangels were grown on small plots at the Cruickshank Botanic Gardens. The plots were too small to give any reliable weights of crop per acre, but samples of all the varieties were taken and analysed. The analyses of all these are given in Table V. In this Table the different varieties are arranged in order according to the percentages of dry matter which they gave.

It will be seen that, as in Table II., Kinaldie and Smith's Purple Top head the list in swedes, while Centenary is much below any other variety either of swedes or yellows. It will also be noticed that, just as in the averages in Table II., the highest of the yellows is a little below the lowest of the swedes in percentage of dry matter. The two varieties of mangels are much above the best of the swedes in both dry matter and sugar.

TABLE V.

Composition of Roots from Cruickshank Botanic Gardens.

Swedes.

No.	Name.	Per Cent. Solids.	Per Cent. Sugar.
1	Smith's Purple Top	12·82	4·71
2	Kinaldie	12·55	5·80
3	Brydon's New Deep-rooted	12·53	5·05
4	Holborn Kangaroo	12·38	5·09
5	Webb's Imperial	12·32	5·72
6	Fell's Bronze Top	12·06	4·72
7	Barron's	11·83	5·21
8	Balmoral	11·71	4·86
9	Drummond's Stirling Castle	11·71	5·48
10	Webb's Giant King	11·69	4·42
11	Drummond's Extra Improved	11·62	4·78
12	Carter's Elephant	11·62	4·89
13	Webb's New Buffalo	11·59	5·45
14	Sutton's Magnum Bonum	11·46	4·96
15	Seafield Crimson	11·31	5·37
16	Tait's Best of All	11·27	5·35
17	Corsicstone	11·26	5·26
18	Inverquhomery	11·13	5·04
19	XL All	11·08	5·26
20	Webb's New Arctic	11·07	5·67
21	Garton's Model	10·81	5·00
	Average	10·70	5·15

Yellows.

No.	Name.	Per Cent. Solids.	Per Cent. Sugar.
1	Birnie's Purple Top	10·33	4·72
2	Smith's Green Top	10·19	4·62
3	Challenger	10·14	4·67
4	Corsicstone	9·89	4·45
5	Barron's	9·55	4·59
6	Old Meldrum	9·43	4·64
7	Smith's Purple Top	9·31	4·54
8	Webb's Invincible	8·73	4·40
9	Centenary	7·76	4·35
	Average	9·48	4·55

Mangels.

No.	Name.	Per Cent. Solids.	Per Cent. Sugar.
1	Long Pink	14·76	9·77
2	Yellow Globe	13 33	8·18
	Average	14·05	8·98

TURNIP VARIETY EXPERIMENTS IN ROSS-SHIRE.

In conjunction with the Agricultural Departments of Aberdeen and Cambridge Universities, the Agricultural Sub-Committee of the County Council of Ross and Cromarty arranged a test of sixteen varieties of swedes and yellow turnips at several centres in the county.

The farms were selected to represent different types of soil and climate ; but, owing to attacks of wireworm and finger-and-toe, returns were received from the following farms only :—

Farm.	Occupier.	Soil.
Cullisse	Mr. John Gordon	Strong Clay Loam.
Tomich	Mr. R. Macfarlane	Loam.
Teananich	Mr. H. McIver	Peaty Loam.
Rosefarm	Mr. A. A. Middleton	Loam.
Navity	Mr. W. J. Lumsden	Mixed Loam.
Rockfield	Mr. Finlay Munro	Light Loam.

The following varieties of swedes were included in the trial :—

Purple Top Globes and Ovals.

Magnum Bonum	Sutton.
Imperial	Webb.
Best of All	Dickson, Brown & Tait.
Extra Improved	Drummond.

Purple Top Tankard.

Elephant	Carter.

Bronze Top Globes and Ovals.

Model	Garton.
Darlington	Brydon.
XL. All	,,
Fell's Bronze Top	Fell.
Improved Bronze Top	Drummond.

Bronze Top Tankards.

New Arctic	Webb.

Green Top Globe.

Lord Derby.

The above list includes all types of main crop swedes grown

in Great Britain. Local varieties may be known under other names, but all such locally selected sub-varieties are referable to one or other of the above types.

Yellows. Only four varieties of yellows were tried.

Centenary	Sutton.
Sittyton Purple Top . . .	Smith & Sons.
Old Meldrum.	
Challenger Green Top.	

Treatment and Manur ng.

The swede seed was sent by Professor Middleton of Cambridge University, and the seed of the yellows came from Aberdeen University.

The experimenters were requested to use 5 cwt. Superphosphate and 1 cwt. Sulphate of Ammonia per acre, along with the ordinary dressing of farm-yard manure.

All the plots were in duplicate, and the crops were weighed and the samples taken in January by Mr. Frank Middleton of Rosefarm. The sampling was done in the manner described on page 31, except that the sampler was driven through the bulb horizontally and not from the shoulder, and, instead of taking a sample from every bulb in a measured area, average-sized bulbs of each variety were bored and 200 cores retained for analysis.

Object of the Experiment.

The chief object of the experiment was to test the composition of different types of swedes and yellows both in Ross-shire and in the south of England, and thus to throw more light on the relative feeding values of well known varieties.

It was also intended to ascertain the cropping power where that was feasible.

Cropping Power.

There is so little difference in the average weight of crop per acre that the real difference must be looked for in the composition. The yield of a turnip crop is dependent on so many contingencies that even duplicate plots of the same variety will show as great a difference as that between the largest and smallest crop of different varieties on the same field.

For example, at Cullisse, on one set of plots Webb's Arctic produced 4½ tons more than on the other set, but the difference between Arctic and Imperial in one set is 5 tons, and in the other only 10 cwt., so that, judging from one set of plots, Arctic is 20 per cent. better than Imperial, while on the other set it is only about 2 per cent. better.

These duplicates were on the same field of exceptionally uniform soil, and within 100 yards of each other. Even if the conditions as regards soil, manuring, seed and cultivation are alike, equality of results is still unassured, for it is scarcely conceivable that crows, fly, wireworm, finger-and-toe and mildew will attack the same number of plants and affect them to the same extent in each plot. Again, even if duplicate plots on the same field corroborate each other, what is to be said about the same seed on different farms, for we find that at Rosefarm, Imperial was a better cropper than nine other varieties, but at Cullisse these nine other varieties were better croppers than Imperial. It is clear that if cropping tests of

TABLE VI.

Weight of Crop per Acre at each Farm.

	Cullisse		Tomich.		Teananich.		Rosefarm.		Average.	
Swedes.										
Webb's Imperial	22	10	21	12½	9	17¼	26	6	20	1¼
Sutton's Magnum Bonum	24	4½	23	14	10	18¼	21	5	20	0½
Webb's New Arctic	25	5	18	13½	11	17¾	22	12	19	12
Tait's Best of All	24	11½	21	7¼	7	10¼	23	14	19	5
Brydon's Darlington	23	19	18	4½	8	16¾	26	3	19	5
Drummond's Extra Improved	23	0¾	18	9	12	6½	22	9	19	1
Drummond's Improved Bronze Top	24	5	16	5¼	9	11¾	26	0	19	0½
XL All	24	12¼	18	12½	9	6¼	22	6	18	14¼
Lord Derby	24	4¼	18	19	8	2¼	21	18	18	5¾
Garton's Model	23	4	16	1¾	8	2¾	24	18	18	1½
Carter's Elephant	21	9½	16	15¾	11	0½	18	13	16	19½
Fell's Bronze Top	22	9	15	18¾	7	12¾	20	0	16	10
Yellows.										
Challenger	30	12¼	...		16	16¼	25	0	24	2⅚
Sittyton Purple Top	25	7¼	...		16	8¾	27	11½	23	2½
Old Meldrum	27	16¼	...		14	1¾	25	15	22	11
Centenary	25	8½	...		5	10	32	15	21	4½

turnips are to be relied on, the plots must be duplicated on each field, they must be of a large size (from $\frac{1}{8}$ to $\frac{1}{4}$ of an acre), and the whole of each plot must be weighed. If turnips, like potatoes, were universally sold off the farm, varieties of exceptional cropping power would have been evolved by this time, but as 5 tons more or less per acre in a good crop is difficult to judge by the eye, and the weighbridge is seldom used, the real existing differences are neglected. From which it follows that all sound turnip seed of one type, under whatever name, will produce a normal crop in normal years, the inferior strains of that type having been weeded out at the point when the eye became an unimpeachable judge.

From the table above it is only clear that Fell's Bronze Top and Holborn Elephant are inferior croppers, while Magnum Bonum and Imperial are, on the average, good. At Teananich the crop was ravaged by finger-and-toe.

Composition and Feeding Value.

The utility of a turnip crop for making beef or mutton must depend chiefly on the amount and quality of dry matter and sugar which it contains, and that there are considerable differences in the quantity of dry matter found in one variety as compared with another the table below will show.

TABLE VII.

SHOWING THE PERCENTAGE OF DRY MATTER AND OF SUGAR CONTAINED BY EACH VARIETY ON EACH FARM, THE VARIETIES ARRANGED IN AVERAGE ORDER OF MERIT.

		CULLISSE.	TOMICH.	TEANANICH.	ROSEFARM.	AVERAGE.
Fell's Bronze Top	D. M.	11·2	11·3	12·4	11·5	11·6
	Sugar	7·6	7·5	8·3	7·4	7·7
Drummond's Extra Improved	D. M.	11·7	10·5	12·2	11·4	11·45
	Sugar	7·6	7·4	8·0	7·4	7·6
Webb's Imperial	D. M.	11·6	10·4	12·6	10·8	11·35
	Sugar	7·7	7·6	8·1	7·4	7·7
Webb's New Arctic	D. M.	10·7	11·2	11·7	11·5	11·27
	Sugar	7·5	7·2	8·2	7·4	7·57
Lord Derby	D. M.	10·7	9·9	12·1	11·5	11·05
	Sugar	7·4	6·9	8·3	7·4	7·5
Brydon's Darlington	D. M.	10·6	10·8	12·0	10·8	11·05
	Sugar	7·2	7·3	7·9	7·3	7·42
Sutton's Magnum Bonum	D. M.	10·8	10·3	12·5	10·5	11·02
	Sugar	7·5	7·1	8·4	6·9	7·47
Dixon, Brown & Tait's Best of All	D. M.	10·0	10·1	12·3	11·2	10·9
	Sugar	7·2	7·0	8·0	7·3	7·37
Carter's Holborn Elephant	D. M.	10·4	10·0	11·9	11·1	10·85
	Sugar	7·2	7·0	7·7	7·1	7·25
Brydon's Excel All	D. M.	9·8	10·4	11·1	10·2	10·37
	Sugar	7·1	7·1	7·8	7·0	7·25
Garton's Model	D. M.	9·9	10·0	11·3	9·8	10·25
	Sugar	7·3	6·8	7·9	7·0	7·25
Drummond's Improved Bronze Top	D. M.	9·6	9·6	11·1	10·2	10·12
	Sugar	7·2	7·1	7·6	6·9	7·2
Average	D. M.	10·58	10·4	11·93	10·87	10·94
	Sugar	7·37	7·17	8·01	7·2	7·44

The analyses of the roots were carried out by Mr. T. B. Wood, M.A., Reader in Agricultural Chemistry, Cambridge University, and from Mr. Wood, Table VII. has been received.

The significance of these figures may be made clear in the following way. If we suppose that each kind of swede grew a crop of 20 tons per acre, and value the dry matter at 3/6 per cwt., then the difference in value per acre between the best and the worst was, at Cullisse, 29/5, at Tomich. 23/9, at Teananich, 21/-, at Rosefarm, 23/9.

When the actual results are considered, however, the difference is greater; as much as £3 per area at Tomich, or double an average rent in the North.

Farm.	Variety.	Crop per Acre.	Dry Matter per Acre.	Value per Acre at 3/6 per Cwt. of Dry Matter.
		Tons Cwt.	Tons Cwt. Lb.	
Cullisse	Webb's Artic	25 5	2 14 4	£9 9 1
	Carter's Holborn Elephant	21 19½	2 4 74	7 16 1
Tomich	Sutton's Magnum Bonum	23 14	2 8 92	8 11 4
	Drummond's Improved Bronze Top	16 5¼	1 11 25	5 9 5
Teananich	Drummond's Extra Improved	12 6½	1 10 8	4 13 3
	Garton's Model	8 2¾	0 18 44	3 4 7
Rosefarm	Webb's Imperial	26 6	2 6 89	9 19 2
	Carter's Holborn Elephant	18 13	2 1 44	7 5 7

Table VIII. shows the total quantity of feeding material produced by each kind of swede at each centre.

The yellow turnips were not analysed as it was found impossible to deal with such a large number of samples, but on page 29 will be found the results of the test in Aberdeenshire and Banffshire with the same seed.

TABLE VIII.

Table showing the Quantity of Dry Matter and of Sugar per Acre Produced by each Variety on each Farm, the Varieties Arranged in Average Order of Merit.

		Cullisse.			Tomich.			Teananich.			Rosefarm.			Average.		
		Tons	Cwt.	Lb.	Tons	Cwt	Lb.	Tons	Cwt.	Lb.	Tons	Cwt.	Lb.	Tons	Cwt.	Lb.
Webb's Imperial	D. M.	2	12	22	2	4	110	1	4	95	2	16	89	2	4	79
	Sugar	1	14	73	1	12	97	0	15	108	1	18	103	1	10	67
Webb's Arctic	D. M.	2	14	4	2	1	94	1	7	91	2	11	109	2	3	103
	Sugar	1	17	98	1	6	99	0	19	55	1	13	50	1	9	47
Drummond's Extra Improved	D. M.	2	13	100	1	18	84	1	10	8	2	11	20	2	3	53
	Sugar	1	15	2	1	7	34	0	19	81	1	13	25	1	8	92
Sutton's Magnum Bonum	D. M.	2	12	26	2	8	92	1	7	31	2	4	70	2	3	27
	Sugar	1	16	37	1	13	73	0	18	37	1	9	36	1	9	46
Brydon's Darlington	D. M.	2	10	86	1	19	38	1	1	23	2	16	54	2	1	106
	Sugar	1	14	55	1	6	67	0	15	107	1	18	20	1	8	90
Tait's Best of All	D. M.	2	9	17	2	3	20	0	18	52	2	13	10	2	0	109
	Sugar	1	15	43	1	9	103	0	12	2	1	14	67	1	7	110
Lord Derby	D. M.	2	11	91	1	17	58	0	19	71	2	10	41	1	19	94
	Sugar	1	15	94	1	6	17	0	13	51	1	12	46	1	6	108
Brydon's XL All	D. M.	2	8	27	1	18	83	1	0	75	2	5	55	1	18	32
	Sugar	1	14	105	1	6	49	0	14	58	1	11	25	1	6	87
Drummond's Improved Bronze Top	D. M.	2	6	63	1	11	25	1	1	31	2	13	4	1	18	3
	Sugar	1	14	103	1	3	10	0	14	63	1	15	98	1	7	12
Fell's Bronze Top	D. M.	2	10	31	1	16	2	0	18	105	2	6	0	1	17	90
	Sugar	1	14	14	1	3	1	0	12	76	1	9	67	1	5	8
Carter's Holborn Elephant	D. M.	2	4	74	1	13	58	1	6	29	2	1	44	1	16	51
	Sugar	1	10	102	1	3	51	0	16	109	1	6	54	1	4	51
Garton's Model	D. M.	2	5	104	1	12	19	0	18	44	2	8	89	1	16	36
	Sugar	1	13	98	1	1	98	0	12	87	1	14	87	1	5	92
Average	D. M.	2	9	109	1	18	94	1	2	101	2	9	103	2	0	46
	Sugar	1	14	95	1	6	86	0	15	60	1	13	20	1	7	66

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REPORT

ON

THE COMPARATIVE MERITS OF VARIETIES OF OATS

1903-4

(MORAYSHIRE FARMER CLUB)
(COUNTY COUNCIL OF ROSS AND CROMARTY)

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OAT VARIETY TRIALS.

In the Spring of 1903 the Morayshire Farmer Club allocated part of its funds for the purpose of testing varieties of oats in the County. The Agricultural Department of the University of Aberdeen was invited to co-operate in the work. At the same time the Agricultural Sub-committee of the County Council of Ross and Cromarty arranged a similar series of experiments, and contributed a sum of money to the University Agricultural Department for the purpose of this Report.

The Report deals with the results of the trials and chemical analyses in the following order:—

(*a*) The grain and straw-producing power of the oat varieties.
(*b*) The milling quality of the oats.
(*c*) The composition of grain and straw.

NOTE OF ACKNOWLEDGMENT.

Thanks are due to the occupants of the farms named in the Report, who gave the use of their land, free of charge, for the purposes of the experiments, and who incurred much trouble and some expense in their supervision and execution.

MORAYSHIRE OAT EXPERIMENT.

The oat experiments which form the subject of this Report were carried out by the Morayshire Farmer Club in co-operation with the Department of Agriculture of the University of Aberdeen.

The growing of oats is an important feature of Morayshire farming, and these experiments were organised with the purpose of assisting the members of the Morayshire Farmer Club to choose among the recently introduced varieties of oats those most suitable for local circumstances. The southern seaboard of the Moray Firth grows oats of fine quality, much in demand for seed and milling, and probably in few parts of Scotland is a larger proportion of grain sold off the farm. The dry early climate of Morayshire is not productive of straw in a normal year, but on account of the large acreage under white crop, straw for food and litter is seldom deficient. Every grower of oats has presumably the same object in view, *viz.*, to obtain the largest net profit per acre, but the object may not be attained by the same means in every part of the country. The Wigtonshire farmer, for example, must look well to the straw, for only 28 per cent. of his arable land grows corn, while in Morayshire ten more acres in every hundred are under white crop.

Or, to put it from the consumer's standpoint, the Morayshire bullock can look forward to an acre and a half of straw for winter keep, while the Wigtonshire cow must be content with little more than half an acre.

Varieties which are "grain producers" rather than "straw producers," and which give not only a large yield of grain but grain of heavy bushel weight and good milling power are therefore suitable for Morayshire.

The following eight varieties were selected for trial :—

1. Potato.	5. Waverley.
2. Newmarket.	6. Goldfinder.
3. Storm King.	7. Banner.
4. Sandy.	8. Siberian.

Potato and Sandy were included in the test because they are well-known old varieties with which to compare the newer, and because they are in considerable demand for seed purposes in

less favoured parts of the country. Sandy, in particular, is sought after for seed on the late farms.

Farms Selected.

The trials were carried out on three farms selected to represent three types of soil common in the Moray lowlands. At Barmuckity (Mr. James Robertson) the experimental plots were on a fertile sandy loam, free from stones. At Burgie (Mr. H. M. S. Mackay) the soil is heavier but still only a gravelly loam representative of the sea-coast farms, while at Old Duffus (Mr. Lewis G. Fraser) the oats were grown on a stiff cold clay full of substance, but difficult to work, and only 9 feet above sea-level. The plots were $\frac{1}{4}$ of an acre in extent except at Burgie where the lie of the land would allow $\frac{1}{8}$ of an acre plots only. The land was selected and the plots were measured off by a representative of the Agricultural Department and care was taken to exclude all "mids" or "hints" and other inequalities from the plots. The sowing, threshing and weighing were superintended by the Secretary and members of Committee.

The Season.

The season was favourable to the growth of oats except at Old Duffus which suffered from the excessive rainfall. The crops were secured in good condition on all the farms.

The Seed.

An equal number of grains of each variety was sown per acre.

The weight of 500 grains of Potato oats showed by calculation that 3,000,000 seeds were contained in rather more than 5 bushels, which is the local seeding. On the basis of 3,000,000 seeds per acre the following quantities of seed were required :—

1. Potato	$5\frac{1}{2}$	bushels	of 42 lbs.
2. Newmarket	7	,,	,,
3. Storm King	$7\frac{1}{2}$	,,	,,
4. Sandy	$4\frac{1}{2}$	,,	,,
5. Waverley	$6\frac{1}{4}$	,,	,,
6. Goldfinder	$6\frac{1}{4}$	,,	,,
7. Banner	6	,,	,,
8. Siberian	6	,,	,,

There was no evidence that the seeding was too heavy; on the contrary Storm King, of which 7½ bushels were sown, was if anything too thin.

Grain Sown Compared with Grain Harvested.

On the average the grain harvested was inferior in bushel weight to the grain sown, but the deterioration was slight and may have been due to the superior dressing of the purchased seed.

Yield of Dressed Grain per Acre.

The Table below shows the order of merit of the eight varieties and the weight of dressed grain in centals per acre at each farm.

TABLE I.

Order of Merit and Dressed Grain in Centals.

Barmuckity.		Burgie.		Old Duffus.	
Variety.	Centals per Acre.	Variety.	Centals per Acre.	Variety.	Centals per Acre.
Banner	38·44	Banner	35·48	Goldfinder	32·48
Goldfinder	36·04	Siberian	34·68	Banner	30·82
Waverley	35·86	Goldfinder	33·40	Newmarket	30·66
Siberian	34·72	Newmarket	32·48	Siberian	30·45
Newmarket	34·56	Waverley	31·24	Waverley	29·28
Storm King	34·12	Storm King	30·32	Storm King	26·66
Potato	30·46	Potato	26·28	Potato	22·93
Sandy	23·36	Sandy	23·32	Sandy	17·28

A cental = 100 lbs. or 2½ bushels of 40 lbs., and is more convenient for comparing yields of grain than a measure such as a bushel, which may contain various weights.

The position of best grain producer belongs to Banner, although it is second to Goldfinder at Old Duffus. Storm King, Potato and Sandy occupy the same relative position at the foot of the list on each farm. The results so far as grain is concerned are so consistent that we are justified in drawing deductions from the average figures.

The Table below shows the average quantity of total grain, the average quantity of dressed grain and the percentage of light grain for each variety.

TABLE II.

THE AVERAGE QUANTITY OF TOTAL GRAIN IN CENTALS AND BUSHELS OF 42 LBS. AND THE PERCENTAGE OF LIGHT GRAIN FOR EACH VARIETY.

Morayshire.

VARIETY.	AVERAGE QUANTITY OF TOTAL GRAIN.	BUSHELS OF 42 LBS.	AVERAGE QUANTITY OF DRESSED GRAIN.	BUSHELS OF 42 LBS.	PERCENTAGE OF LIGHT GRAIN TO TOTAL GRAIN.
	Centals.	Bushels.	Centals.	Bushels.	Per Cent.
Banner . . .	37·00	88	34·91	83	5
Goldfinder . . .	35·95	85½	33·97	81	5
Siberian . . .	35·69	85	33·28	79¼	6
Newmarket . .	34·21	81½	32·56	77½	4
Waverley . . .	33·96	80¾	31·86	75½	6
Storm King . .	32·24	76¾	30·36	72¼	5
Potato . . .	30·20	72	26·55	63¼	12
Sandy	26·56	63¼	21·32	50¾	19

Banner has produced 13 centals or 33 bushels more of first quality grain than Sandy, and 8 centals or 20 bushels more than Potato. The superiority of the "new" varieties is clear, but shows better when the dressed grain only is considered. In other words the new varieties give a larger proportion of good grain as well as a heavier total yield. As grain producers Potato and Sandy may be left out of consideration in those trials. Where grain rather than straw is desired, an oat that yields 35 per cent. of grain to 65 per cent. of straw, must give place to one like Banner or Siberian where 45 per cent. of the produce is grain and 95 per cent. of the grain is good. Proceeding from the worse to the better, Storm King shows itself the worst of the grain producers but it has one outstanding merit to which we shall recur. There is little to choose between Waverley and Newmarket, but the latter has the

advantage, yielding a few lbs. more of total grain than Waverley, and a much larger proportion of good grain.

Between Siberian and Goldfinder in the matter of grain there is still less to choose. Banner remains indisputably the best grain producer on the light land, and the best average grain producer on all the farms.

Yield of Straw.

Apparently the soil has but slightly affected the relative position of the varieties as regards the production of grain. The table below will indicate, however, that the soil affects the straw production, else why is Sandy first at Burgie and fifth at Old Duffus? We are prepared to find that Banner is a poor straw producer at the same place but not to find that Sandy is worse. At Barmuckity, Waverley is third for both grain and straw, and judging from that centre only, the observer would be justified in assuming that Waverley is a reliable all-round variety, but at Burgie and Old Duffus Waverley is the worst straw producer.

TABLE III.

Produce of Straw and Chaff per Acre on each Farm, arranged in Order of Weight.

Barmuckity.			Burgie.			Old Duffus.		
Variety.	Tons.	Cwts.	Variety.	Tons.	Cwts.	Variety.	Tons.	Cwts.
Potato . .	2	16¾	Sandy .	2	17¾	Potato .	1	18½
Sandy . .	2	10½	Potato .	2	13½	Newmarket	1	18½
Waverley .	2	8½	Goldfinder .	2	13¼	Storm King	1	16½
Newmarket .	2	6½	Siberian .	2	10¾	Siberian .	1	11
Siberian .	2	3⅛	Storm King	2	7½	Banner .	1	8¼
Storm King .	2	2⅛	Newmarket	2	6¾	Waverley .	1	5¾
Banner .	2	2	Banner .	2	6¼	Sandy .	1	5
Goldfinder .	2	1¾	Waverley .	2	4½	Goldfinder .	*	

* The produce of Straw from Goldfinder was so small that the figures have been excluded, as likely to be misleading.

Three points are apparent from the returns of the yield of straw and grain: (1) Potato produces the greatest weight of straw; (2) Siberian is a good general purpose or intermediate variety and the same may be said of Newmarket; (3) Banner though the best grain producer is in no instance the worst straw producer.

To weigh one variety against another according to the circumstances which appeal to him must be left to the individual reader, but it may be helpful to place the results in such a way that a comprehensive view may be obtained of the comparative merits of the different varieties. Their merits must be compared in similar terms; the simplest and most appealing are terms of money values.

A comparison in terms of money value is not accurate, however, for 336 lbs. of Goldfinder, natural weight 37 lbs. per bushel, may not sell for the same price as 336 lbs. of Potato of 42 lbs. per bushel. Nevertheless, for the sake of comparison, we must assume similar values for similar weights.

Assuming that the dressed grain is worth 18s. per quarter and the straw 40s. per ton for feeding, the order of total value of produce is as follows:—

Goldfinder	£14	3	7
Banner	13	8	4
Newmarket	13	4	5
Siberian	13	3	6
Waverley	12	12	10
Storm King	12	8	10
Potato	12	3	2
Sandy	10	3	10

A rise of a shilling or two in the price of grain would increase the value of the first four varieties in greater proportion than the last four.

Time Taken to Mature.

Hitherto only the grain and straw producing qualities have been considered, and though they are the most important, certain minor characteristics must be kept in mind.

Earliness or rapidity of growth is a particularly valuable

quality in the grain crops where a week may mean the difference between a good and a bad harvest.

The past season, though exceptionally late, probably did not affect the relative earliness and lateness of the varieties under experiment, but merely lengthened their growing period.

TABLE IV.

TIME TAKEN TO MATURE.

Variety.	Number of Days Required to Mature.	Number of Days Over or Under the Average.	
		Under.	Over.
Storm King	136	12	—
Newmarket	144	4	—
Potato	145	3	—
Banner	149	—	1
Sandy	150	—	2
Siberian	152	—	4
Waverley	154	—	6
Goldfinder	160	—	12

The tendency to early ripening is strong in Storm King, which was ready for cutting more than a week before any other on all the farms. The average difference between the earliest and the latest was more than three weeks. At Old Duffus the difference was five weeks. Goldfinder was invariably the last to mature.

ROSS AND CROMARTY OAT EXPERIMENT.

THE oat experiments carried out by the Agricultural Sub-Committee of the County Council of Ross and Cromarty were planned on the same lines and organised for the same purpose as those conducted in Morayshire. With one exception (Hamilton substituted for Siberian) the same varieties were tested, but owing to various causes the results of the trials in Ross and Cromarty are not strictly comparable with the Morayshire results, and it is therefore better to deal with them in a separate report.

THE SEASON.

In Morayshire the season was drier, and the harvest weather almost all that could be desired, but in Ross-shire, where the crops on all the plots were heavy and long in the straw, rain and wind before and after cutting introduced new openings for unreliable results. Many of the plots were lodged and twisted, making cutting difficult and the produce of straw impossible to estimate.* At Dunglass where the crops were nearly 6 feet high the weather injured them to such an extent that it was considered useless to weigh them. At Rockfield also, only five of the plots were weighed, the weather and certain inequalities in the soil making the others unreliable. But in a bad harvest grain is lost as well as straw, and in a trial of oat varieties bad weather is the worst of all the sources of error. The wind and rain may deal impartially with one area, but different kinds of oats will be differently affected.

Storm King with short stiff straw will stand up better and give a better account of itself than Goldfinder.

Oats with brittle necks, like Newmarket and Banner, will lose

* Effect of season: In Morayshire 40 per cent. of the produce was grain, in Ross and Cromarty only 35 per cent. was grain.

their heads when handled over much, and alternate wet and dry will cause undue shedding in Potato. Again, the stations were far apart and suffered bad weather in varying degrees, thus no reliance can be placed upon an average result. Each station must be considered by itself in the light of local knowledge, and the narrowest permissible conclusion is, that in a certain locality, in an abnormal year, after a wet harvest, the results were so and so. That they will be the same in a normal year over a wider area is mere conjecture.

The Stations.

The trials were conducted on the following seven stations :—

Farm.	Occupier.	Soil.
Ballachraggan, Alness	Mr. J. A. Anderson .	Deep rich loam near sea-level.
Davidston, Cromarty .	Mr. J. Middleton . .	Light dry loam.
Dunglass, Conon .	Messrs. W. & J. Peterkin	Deep loam.
Millcraig, Alness .	Mr. C. Dyson Perrins per Mr. J. W. Cuthbert	Gravelly loam, 250 feet above sea-level.
Navity, Cromarty .	Mr. J. W. Lumsden .	Mixed fertile loam.
Rockfield, Fearn .	Mr. Finlay Munro . .	Light dry loam.
Rosehaugh, Avoch .	Mr. J. D. Fletcher . .	Deep black loam.

At Dunglass none, and at Rockfield five only of the plots were weighed.

The Seed.

Each plot was originally intended to contain ¼ of an acre, and seed was provided for that area, but it was finally decided to sow a smaller proportion of seed (2,500,000 grains per acre) and the plots were slightly enlarged. The results in all cases are given per acre.

TABLE V.

Showing the Varieties of Oats Tested, the Weight of 500 Grains in Grams, the No. of Lbs. per $\frac{1}{4}$ Acre at rate of 2,500,000 Grains per Acre, and the Approximate Number of Bushels per Acre.

Variety.	Weight of 500 Grains.	Lbs. per $\frac{1}{4}$ Acre.	Bushels per Acre.
	Grams.	Lbs.	Bushels.
Potato	16·90	46½	4½
Newmarket	21·56	59¼	5½
Storm King	20·47	56¼	5¼
Sandy	13·81	38	3¾
Waverley	20·70	57	5¼
Goldfinder	20·12	55¼	5¼
Banner	20·01	55	5¼
Hamilton	16·05	44¼	4¼

It will be seen that the trial included seven of the varieties used in Morayshire, the eighth variety, Siberian, being replaced by Hamilton, a favourite oat in Ross-shire.

The Soils.

The soils were fairly uniform in texture. They varied from light dry loams to deep black loams, but none could be described as clay or sand, and all were in good, and some in high condition.

Under normal conditions therefore the results should have shown some consistency, but it must be admitted that they are exceptionally contradictory.

TABLE VI.

Showing the Total Quantity of Grain Grown on each Farm. The Varieties Arranged in Order of Yield of Grain.

	Navity.	Rosehaugh.	Davidston.	Ballach-raggan.	Millcraig.	Rockfield.	Average.
	Centals.	Centals.	Centals.	Centals.	Centals.	Centals.	Centals.
Hamilton . .	33·83	29·25	32·27	35·73	35·76	29·82	32·77
Waverley . .	38·52	36·67	34·46	34·84	22·50	22·68	31·61
Banner . . .	25·46	32·03	30·96	36·68	32·18	—	31·46
Potato . . .	27·65	40·62	26·90	33·32	28·48	29·89	30·89
Goldfinder . .	28·37	27·04	26·85	33·55	35·11	—	30·18
Newmarket . .	31·48	35·65	30·08	32·77	24·62	19·74	29·05
Storm King . .	27·14	41·44	27·62	23·20	22·82	—	28·44
Sandy . . .	26·13	32·40	27·99	31·21	17·56	27·30	25·43

THE BEST GRAIN PRODUCER.

Hamilton *versus* Potato.

Hamilton has produced, on the average, more total grain than any other variety, and with the exception of Waverley, more dressed grain also. A comparison of Hamilton with Potato shows that on five of the six farms from which returns have been made, Hamilton is easily superior to Potato. At the sixth farm, Rosehaugh, Hamilton being near the fence was much destroyed by birds, but the difference of 35 bushels per acre in favour of Potato cannot be entirely debited to the birds, and we must assume that here, at anyrate, Hamilton is inferior to Potato.

Hamilton *versus* Potato.

(Average of Five Farms.)

	Total Grain per Acre.		Dressed Grain per Acre.		Light Grain per Acre.	Average Percentage of Grain in Crop.
	Centals.	Bushels.	Centals.	Bushels.	Lbs.	
Hamilton .	$33\frac{1}{2}$	$79\frac{3}{4}$	$28\frac{1}{2}$	$67\frac{3}{4}$	504	34
Potato . .	29	69	$25\frac{1}{2}$	$60\frac{3}{4}$	347	34

Hamilton has produced over a quarter of total grain and nearly a quarter of dressed grain more than Potato.

Waverley *versus* Newmarket.

Waverley is uncertain in its production. While it has given more dressed grain than any other variety it is only at two places that it has been unmistakably first as a grain producer, though it has never been lower than fifth at any centre. It takes a medium place in the Morayshire trials alongside Newmarket, but while in Morayshire there was little to choose between them, in Ross-shire, Waverley is considerably and uniformly superior except at Millcraig. It is noticeable that Davidston and Navity, where Waverley has done best, are within a mile or two of each other.

Waverley *versus* Newmarket.

(Average of Five Farms.)

	Total Grain per Acre.		Dressed Grain per Acre.		Light Grain per Acre.	Average Percentage of Grain in Crop.
	Centals.	Bushels.	Centals.	Bushels.	Lbs.	
Waverley .	$33\frac{1}{2}$	$79\frac{3}{4}$	$31\frac{1}{4}$	74	241	39
Newmarket .	30	71	$28\frac{1}{2}$	$67\frac{1}{2}$	147	36

Banner *versus* Potato.

Banner and Potato have produced exactly the same quantity of total grain and of dressed grain, but in bulk of straw Potato

eclipses Banner, and in these trials is, therefore, more valuable. Again, however, a local connection is apparent. At Ballachraggan and Millcraig, which are comparatively near, Potato is inferior to Banner, which at the former centre is the heaviest cropper of all the varieties.

Goldfinder.

This oat, though a heavy cropper, is very late and usually rather weak in the straw. It is probably found at its worst in a late wet season and it is, therefore, not surprising that it should have given so poor an account of itself in these trials. At one centre it produces the heaviest crop of grain, but it shares with Storm King and Sandy the lowest average position in the test.

Storm King.

An early ripening oat with stiff, strong straw would be expected to do well in the season described. Such an oat is Storm King. But it has not fulfilled expectations.

At Rosehaugh it tops the list with a production of 41½ centals or the enormous crop of 99 bushels of grain per acre, but at the four remaining stations from which returns have been supplied it competes with Sandy for the average lowest place.

Sandy.

Sandy is not a grain producer, but in a cold season and bad weather it seems to suffer less than the new varieties. In Morayshire, Banner produced 11 centals, or 26 bushels more than Sandy, but in Ross-shire the difference is only 3¾ centals, or about 9 bushels.

Other Varieties.

At Navity and Davidston, Tartar King was tested alongside the experimental plots under similar conditions. At Navity it proved one of the best and at Davidston one of the worst.

At Navity, Excelsior (white) was also tested and gave a return inferior only to Waverley and Hamilton.

Home-grown Seed *versus* Purchased Seed.

An interesting test between home-grown and purchased seed of the same variety was made at Davidston. The variety tried was Newmarket, which Mr. Middleton had already grown on the farm.

The result is in favour of the purchased seed but the difference is small.

	Total Grain. Bushels of 42 lbs.	Dressed Grain. Bushels of 42 lbs.
Newmarket (purchased seed) . . .	71	70
Newmarket (home-grown seed) . . .	69	67

Effect of Season on Weight per Bushel.

It is interesting to compare the original bushel weight of the seed with its produce in the bad season of 1903.

TABLE VII.

Showing Weight per Bushel of Dressed Grain, of the Original Seed and of its Produce in 1903.

Variety.	Original.	Navity.	Rosehaugh.	Davidston.	Ballach-raggan.	Millcraig.	Rockfield.	Average.
Potato . . .	44	40	41½	38½	41½	40	41	40½
Newmarket . .	43	43	44½	40	43	44	41	42½
Storm King . .	42	43	38	39½	41	42½	40	41
Sandy . . .	43	41	40½	38½	40	39	40	40
Waverley . .	46	40	43	38½	41½	43½	39	41½
Goldfinder . .	40	38	39½	37½	37	39½	37	38
Banner . . .	40	41	41	39½	42	39½	38	40
Hamilton . .	44	40	41	38	41	41½	41	40½

The average weight is reduced in all varieties except Banner, but not on all the farms.

Production of Straw.

Returns of the weight of straw and chaff were made from Navity, Rosehaugh, Davidston and Ballachraggan, but on account of the unequal manner in which the straw was lodged and twisted on many of the plots the results cannot be considered truly reliable.

TABLE VIII.

Showing Weight of Straw and Chaff per Acre on each Farm and Average Produce in Order of Yield.

	Navity.		Rose-haugh.		Davidston.		Ballach-raggan.		Average.	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
Sandy . . .	2	10¼	4	3⅝	2	12¼	2	14	3	0
Hamilton . .	2	8¼	3	4½	2	17¾	2	6	2	14⅛
Potato . . .	2	11½	3	12¼	2	1¼	2	7¼	2	13$\frac{1}{16}$
Waverley . .	2	10¾	2	11¼	2	6½	2	0¾	2	7$\frac{5}{16}$
Newmarket . .	2	8½	3	6¾	1	15	1	18¼	2	7⅛
Banner . . .	1	14¾	3	4¾	2	5½	1	16¼	2	5½
Storm King . .	2	1½	3	5⅛	1	19¼	1	12	2	4½
Goldfinder . .	2	1	2	8⅝	2	7½	1	16¾	2	3½
Tartar King . .	1	19¾	—		2	2½	—		—	
Excelsior . .	2	·7¾	—		—		—		—	
Newmarket (Old Seed) . . .	—		—		2	1	—		—	

As in Morayshire, Sandy and Potato take their place as straw producers, but here they have shown themselves good grain producers also. Hamilton, as the best total grain producer as well as the second best straw producer, takes the lead along with Waverley as a general purpose oat in such a season as that of 1903.

Relative Value of Varieties.

The following statement is an attempt to compare the relative money values of the different varieties. The good grain is valued at 18s. per quarter, the light grain at 1s. per bushel, and the straw at 40s. per ton. Neither the grain nor the straw would be of similar value throughout, but in the absence of detailed knowledge we must assume that they are.

Relative Money Value of each Variety on each Farm.

(Arranged in Order of Average Value.)

	Navity.			Rosehaugh.			Davidston.			Ballach-raggan.			Average.		
Waverley .	£13	17	3	£14	3	0	£13	12	0	£13	4	9	£13	14	3
Hamilton .	12	13	0	13	5	6	14	4	0	13	11	9	13	8	7
Potato . .	11	7	6	16	13	9	11	4	0	13	6	0	13	2	10
Sandy . .	10	17	9	15	12	9	12	11	6	13	7	0	13	2	3
Newmarket .	11	17	9	15	10	0	11	8	6	12	18	6	12	18	8
Banner . .	9	0	0	14	2	9	12	11	6	13	4	9	12	4	9
Storm King .	9	15	0	16	16	9	11	2	3	9	4	0	11	14	6
Goldfinder .	10	6	6	11	7	3	11	16	0	12	8	6	11	9	7

The averages are not so instructive as a consideration of the individual stations, in fact, the averages are of little value, for while Storm King is almost the worst on the average list, it is worth £3 per acre more than Hamilton at Rosehaugh and £4 per acre *less* than Hamilton at Ballachraggan.

On the whole the popularity of the old-established strains—Potato, Hamilton, and Sandy—in such years as 1902 and 1903 is justified. By a process of selection the varieties that best withstand the frequent adverse climatic conditions have been retained, and the old strains are the progeny of these; incapable of responding freely to favourable seasons but hardened to low temperatures and able to mature in a deficiency of sunlight.

The new varieties, on the other hand, are frequently the result of crosses with foreign oats of delicate constitution, or the progeny of direct importations from sunnier and hotter climates. Banner is an example.

Nevertheless there is no doubt that in many cases the "new" varieties are far more valuable than the "old". Even in 1903 Waverley is, in total money value of crop, superior to any older strain. It remains to discover under what conditions they will prove more profitable and how they may be still further improved.

A variety experiment is easily made and may prove of the greatest value to the experimenter. The difference in value between one variety and another is often more than the rent, and the cost of discovering the difference is chiefly the trouble of weighing the produce on a selected area. There is no sure test but the weighing machine. Nothing is easier than to misjudge two crops of oats of different kinds. In Morayshire when the growing crops were inspected Siberian was generally put in the lowest place, but the weighbridge proved it the second best.

TABLE IX.

Showing the Complete Results of the Experiments, with the Names of the Varieties and the Farms on which the Trials were Conducted.

Varieties.	Navity.			Rosehaugh.			Davidston.			Ballachraggan.			Millcraig.			Rockfield.		
	Weight per Acre.			Weight per Acre.			Weight per Acre.			Weight per Acre.			Weight per Acre.			Weight per Acre.		
	Total Grain.	Dressed Grain.	Straw and Chaff.	Total Grain.	Dressed Grain.	Straw and Chaff.	Total Grain.	Dressed Grain.	Straw and Chaff.	Total Grain.	Dressed Grain.	Straw and Chaff.	Total Grain.	Dressed Grain.	Straw and Chaff.	Total Grain.	Dressed Grain.	Straw and Chaff.
	Lbs.	Lbs.	Cwts.	Lbs.	Lbs.	Cwts.	Lbs.	Lbs.	Cwts.	Lbs.	Lbs.	Cwts.	Lbs.	Lbs.	Cwts.	Lbs.	Lbs.	Cwts.
Sandy . . .	2613	2213	50	3240	2435	84	2799	2685	52	3121	2859	54	1756	768	—	2730	2478	—
Hamilton . .	3383	2938	48	2925	2427	65	3227	3118	58	3573	3352	46	3576	1998	—	2982	2856	—
Potato . . .	2765	2464	51	4002	3405	72	2690	2581	41	3332	3136	47	2848	1724	—	2898	2772	—
Waverley . .	3852	3482	50	3667	3376	51	3446	3257	46	3484	3383	41	2250	1568	—	2268	2100	—
Newmarket . .	3148	2898	48	3565	3379	67	3008	2944	35	3277	3208	38	2462	1596	—	1974	1764	—
Banner . .	2546	2298	34	3203	2829	65	3096	2952	45	3668	3539	36	3218	1870	—	—	—	—
Storm King . .	2714	2354	41	4144	3845	65	2762	2653	39	2320	2187	32	2282	1500	—	—	—	—
Goldfinder . .	2837	2544	48	2704	2451	48	2685	2594	47	3355	3192	36	3511	1463	—	—	—	—
Excelsior . .	3096	2704	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tartar King . .	2506	2042	—	—	—	—	3304	3221	42	—	—	—	—	—	—	—	—	—
Newmarket (Home-grown seed) .	—	—	—	—	—	—	2786	2709	40	—	—	—	—	—	—	—	—	—

MILLING TESTS.

An investigation of the comparative merits of different varieties of oats is incomplete without a test of their relative milling powers, but a milling test of a number of varieties in small quantities is beset with difficulties. The grain must be from one farm, for it is known that the produce of the same seed grown on different farms may yield very different quantities of meal, owing to some unknown quality of soil or climate.

To dry and mill small quantities with accuracy is very difficult, and when the attempt is complicated by the different sizes and shapes of grain absolute accuracy is impossible without a re-adjustment of the mill stones to suit the characteristic grains.

Nevertheless an attempt has been made to ascertain the milling powers of the varieties experimented on, first by actually milling from one to two quarters of the dressed grain, and second by finding the percentage of kernel to husk as described on page 26.

Some practical millers object to the new varieties of oats on the ground that they produce less meal per quarter than the old; others while finding no fault with the milling power dislike them because they require a different setting of the stones to produce the best results.

Assuming that the country mills are set to grind Potato, Hamilton, and Sandy oats, it would not be surprising to find them showing a marked superiority, but this superiority is by no means evident. It is true that Sandy is on the average the best milling oat in the trials and Newmarket a good second. These results are confirmed by Table XIV., which shows that the same two kinds have the largest percentage of kernel and the smallest proportion of husk; an examination of the Table below, however, will show that there is little consistency in the individual results.

TABLE X.

Showing the Percentage of Meal Obtained from each Variety at each of the Places at which the Trial was Made.

	Rose-haugh.	David-ston.	Navity.	Rock-field.	Bar-muckity.	Average.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Sandy . . .	56·5	58·3	59·3	58·3	57·0	57·8
Newmarket . .	59·2	57·4	54·1	56·8	60·8	57·6
Storm King . .	52·0	54·1	54·1	54·1	61·7	56·4
Potato . . .	59·3	56·2	54·1	52·1	59·4	56·2
Banner . .	55·8	53·5	55·6	54·1	59·9	55·8
Goldfinder . .	53·4	50·9	54·1	54·1	61·1	54·7
Waverley . .	57·2	52·2	54·7	50·0	58·8	54·6
* Hamilton . .	55·3	52·0	52·6	53·8	—	53·4
Average . .	56·0	55·5	54·8	54·1	—	—
Siberian . .	—	—	—	—	60·1	—

* Average of four farms.

The most noticeable features of the Table are the positions of Sandy and Newmarket which are four times above the average, and the position of Hamilton which is in every case below the average.

The individual results are not in accordance with the estimate of milling powers made by weighing the kernel and husk, and until further evidence is available obtained from milling larger quantities of oats no definite comparison of the varieties can be admitted. In these trials Hamilton has not justified its reputation as a good miller, nor have the new varieties occupied the low place to which they are usually assigned in general opinion.

If the different kinds of oats are compared on the basis of the total quantity of meal obtainable per acre, the old varieties will not excel.

Owing to the wet and sunless season of 1903, the old varieties have given a better account of themselves than they are likely to do in a normal year, but even in such unfavourable conditions for the new varieties, it is apparent from the Table below that Potato, Sandy, and Hamilton are eclipsed as meal producers.

TABLE XI.

CALCULATED TOTAL QUANTITY OF MEAL PER ACRE PRODUCED BY EACH VARIETY ARRANGED IN ORDER OF GREATEST PRODUCTION.

	ROSE-HAUGH.	DAVIDSTON.	NAVITY.	BAR-MUCKITY.	AVERAGE.	ROCK-FIELD.
	Lbs. per Ac.	Lbs. per Ac.	Lbs. per Ac.	Lbs. per Ac.	Lbs. per Ac.	Lbs. per Ac.
Waverley .	2085	1344	2116	2125	1917	1134
Storm King .	2165	1661	1456	2140	1855	—
Newmarket .	2053	1490	1706	2141	1847	1122
Potato . .	2327	1512	1501	1946	1821	1509
Banner . .	1781	1662	1356	2343	1785	—
Hamilton .	1588	1817	1770	—	*1725	—
Goldfinder .	1436	1642	1524	2253	1713	—
Sandy . .	1900	1772	1542	1432	1661	1592
Siberian .	one	farm	—	2137	—	—

* Average of three farms only.

The question of milling quality from the grower's point of view is, of course, a question of profit, and if the extreme difference in value for a very superior miller such as Sandy and presumably inferior miller such as Banner is 2s. per quarter, there is still a balance in favour of Banner of £1 per acre; for example:—

6 qrs. of Sandy per acre at 18s. per qr. = £5 8s.
8 qrs. of Banner per acre at 16s. per qr. = £6 8s.

as it may be safely assumed that land which will grow 6 qrs. of Sandy will produce 2 qrs. extra of Banner.

COMPOSITION OF OATS.

In order to throw further light on the values of the varieties of oats grown on the different farms in Morayshire and in Ross and Cromarty, chemical analyses were made of the grain and straw. Average samples of the dressed grain of each kind of oats were taken at each farm and sent to the laboratory. All of these were analysed and the results of the analyses are given below. In the case of the straw it was not considered that any variations in composition would be sufficiently important to justify the great labour of analysing separate samples of each variety from each farm. Average samples were therefore made up in the manner to be described later, representing the straw of each variety from each county and these only were analysed.

Composition of the Grain.

In the analysis of the grain the points which we wished to determine were: (1) the proportion of husk to kernel; (2) the composition of the kernel. As the husk has a very low feeding value for cattle, and has no value in the manufacture of meal, but is practically a portion of the straw, it was not analysed in detail, but we considered it quite sufficient to determine what proportion it bears to the weight of the kernel and of the whole grain in each variety of oat. The value of the grain as food, and its value as a producer of meal, depends on the composition of the kernel and on the proportion which the kernel bears to the husk.

Proportion of Husk to Kernel in Grain.

The proportion of husk to kernel was determined in the air-dried samples. These contained on the average about 12 or 13 per cent. of moisture. The whole of the work of separating the husk from the kernel had to be carried out laboriously grain by grain by hand. We endeavoured to find some mechanical means of carrying out this operation, but none of the means which were tried made a good quantitative separation, so ultimately we had to fall back on the safer but more laborious method. A considerable number of grains, sufficient to give a fair average sample, were weighed. These were then divided into husk and kernel, each of which was then weighed, and the percentage calculated. In all cases the determinations were made in duplicate. The results are given in the following tables:—

TABLE XII.

OATS—SEASON 1903.

Percentages of Husk and Kernel in Air-dried Samples.

Morayshire.

Variety.	Old Duffus.		Barmuckity.		Burgie.		Average.	
	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.
Sandy .	78·21	21·35	76·37	22·70	77·66	22·20	77·41	22·08
Newmarket	76·28	23·65	76·40	22·81	76·22	23·25	76·30	23·23
Goldfinder .	77·51	22·39	76·23	23·14	74·58	24·97	76·10	23·50
Banner .	75·63	24·15	75·43	23·81	75·65	23·85	75·57	23·93
Waverley .	76·75	23·04	75·46	24·35	74·51	24·93	75·57	24·08
Potato .	76·63	23·01	74·39	24·75	73·75	26·03	74·92	24·59
Siberian .	74·73	24·95	74·73	24·65	74·54	25·02	74·66	24·87
Storm King	70·56	29·21	72·35	27·43	70·75	29·14	71·22	28·59

TABLE XIII.

OATS—SEASON 1903.

Percentages of Husk and Kernel in Air-dried Samples.

Ross and Cromarty.

Variety.	Rosehaugh.		Navity.		Millcraig.		Davidston.		Average.	
	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.
Excelsior .	—	—	77·35	22·44	—	—	—	—	77·35	22·44
Goldfinder .	77·23	22·34	77·44	22·21	77·99	21·80	76·63	23·12	77·32	22·36
Newmarket	77·00	22·68	77·45	21·74	77·92	21·98	76·34	23·45	77·17	22·46
Sandy .	77·64	22·01	77·35	22·49	76·71	22·80	75·76	23·77	76·86	22·76
Waverley .	76·99	22·75	77·31	22·48	—	—	76·12	23·60	76·81	22·94
Banner .	76·34	23·31	77·05	22·33	76·66	23·14	75·34	24·23	76·34	23·25
Hamilton .	75·18	24·41	75·82	23·99	76·64	23·23	75·43	24·16	75·76	23·94
Newmarket (Home-grown Seed)	—	—	—	—	—	—	75·51	23·98	75·51	23·98
Potato .	75·81	23·90	75·69	24·03	76·23	23·46	73·93	25·51	75·41	24·22
Tartar King	—	—	75·32	24·53	—	—	74·05	25·64	74·68	25·08
Storm King	70·91	28·84	73·10	26·67	70·49	29·18	70·81	28·89	71·33	28·39

TABLE XIV.

OATS—SEASON 1903.

Percentages of Husk and Kernel in Air-Dried Samples.

Ross and Cromarty, and Morayshire.

Variety.	Average.	
	Kernel.	Husk.
Sandy	77·13	22·42
Newmarket	76·73	22·84
Goldfinder	76·71	22·93
Waverley	76·19	23·51
Banner	75·95	23·59
Potato	75·16	24·40
Storm King	71·27	28·49

In Table XII. the results for all the varieties from each of the farms in Morayshire are given, and also the average of these results for each variety. Table XIII. gives similar results for Ross and Cromarty, while Table XIV. gives the average of the results for both counties for those seven varieties which were grown in both counties.

It will be noticed that in all cases the percentages of husk and kernel added together fall a little short of 100. This is because there was always a little loss of "dust" from the end of oat grain. It will be found that in all cases this loss averages less than ½ per cent.

In all the Tables the results are arranged in the order of the average percentage of kernel, so that those varieties giving the highest percentage of kernel on the average are at the top of the table, and those giving the lowest percentage are at the bottom.

If we leave out of account those varieties like Excelsior and Tartar King, which were grown at only one or two places in Ross and Cromarty, it will be found that in all three Tables Sandy, Newmarket, and Goldfinder are at the top. Closely following them come

Waverley, Banner, and Potato, while Storm King comes a long way behind all the rest. If we consider how small are the differences in percentages of husk between all the varieties, excluding Storm King, the results from all the different farms, and from two counties exhibiting considerable differences of soil and climate, are remarkably consistent. Thus in every individual case Sandy contains more kernel and less husk than Potato. The differences shown for the same variety by the different farms are comparatively small. Generally speaking, we may conclude that all the varieties tested show only slight differences in the proportion of husk to kernel which they contain, with the exception of Storm King, which is a thick-husked variety, and contains a much larger proportion of husk and a smaller proportion of kernel than any of the others.

Composition of Kernel.

The kernels which were removed from the husks, in determining the proportion of husk to kernel, were dried and ground, and the meal so prepared was used for determining the composition of the kernels. The composition of these kernels shows the composition of the pure husk-free oatmeal which could be prepared from the oat in question. In every case the composition of the meal was determined in the completely dry condition. The analyses were all done in duplicate, and were made by the ordinary methods of food analyses.

The constituents of greatest importance in determining the food values of the meals are the albuminoids and oil. Next to these come the "soluble carbohydrates," which, in the case of oatmeal, consist almost entirely of starch. The other constituents are of minor importance. Generally speaking, the albuminoids and oil are each worth about 2½ times as much as the same weight of soluble carbohydrates, so that 1 per cent. of albuminoid or of oil is worth about 2½ per cent. of soluble carbohydrate. The figures showing the oil and albuminoids are, therefore, the most important in judging the relative richness as food of the different varieties of oats. In the following Tables the varieties are arranged according to the percentages of oil which they contain in the average. The variety which gives the highest average percentage of oil comes at the top, and the others follow in order.

TABLE XV.

Composition of Oat Kernels. Dry.

Morayshire. Season 1903.

Variety.	Old Duffus.					Barmuckity.					Burgie.					Average.				
	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.
Potato .	8·54	15·83	69·78	3·08	2·77	8·26	16·31	67·76	3·49	4·12	10·16	15·06	68·34	3·21	3·23	8·98	15·75	68·63	3·26	3·38
Sandy .	8·42	17·37	66·88	3·48	3·85	8·43	16·87	68·75	3·18	2·86	9·38	15·59	68·76	3·71	2·62	8·72	16·61	68·11	3·45	3·11
Goldfinder .	7·18	14·63	72·87	2·65	2·67	5·95	14·15	74·88	2·69	2·33	8·23	14·56	70·82	3·72	2·67	7·12	14·44	72·88	3·02	2·55
Banner .	7 08	13·84	74·00	2·39	2·69	6·59	14·15	73·54	3·36	2·36	7·34	14·84	72·45	3·06	2·31	7·00	14·27	73·34	2·94	2·45
Siberian .	6·71	13·75	74·45	2·80	2·29	6·58	13·65	73·94	2·77	3·16	6·82	15·40	70·90	3·08	3·80	6·70	14·27	73·07	2·88	3·08
Waverley .	6·28	14·44	73·56	3·03	2·69	6·92	15·24	72·14	2·57	3·13	6·50	13·96	74·04	3·02	2·48	6·57	14·54	73·26	2·87	2·76
Newmarket	6·54	14·40	74·28	2·67	2·11	6·05	14·48	73·81	3·11	2·54	7·04	14·87	72·68	3·05	2·36	6·54	14·58	73·60	2·94	2·34
Storm King	5·49	16·46	71·41	3·05	3·59	5·98	16·81	71·18	2·99	3·05	5·87	16·18	70·95	2·90	4·10	5·78	16·48	71·19	2·98	3·57

TABLE XVI.

Composition of Oat Kernels. Dry.

Ross and Cromarty. Season 1903.

Variety.	Rosehaugh.					Navity.					Millcraig.					Davidston, Cromarty.					Average.				
	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.
Potato .	8·99	15·29	69·52	3·49	2·71	9·34	15·53	69·62	2·90	2·61	10·18	14·43	69·62	3·37	2·40	10·02	15·75	68·33	3·38	2·52	9·63	15·25	69·29	3·28	2·56
Hamilton .	9·05	15·81	69·08	3·43	2·63	8·97	15·84	69·79	3·64	2·76	9·45	15·06	69·78	2·77	2·94	9·63	14·37	70·18	3·16	2·66	9·27	15·27	69·47	3·25	2·74
Excelsior .	—	—	—	—	—	9·13	16·50	68·41	3·35	2·61	—	—	—	—	—	—	—	—	—	—	9·13	16·50	68·41	3·35	2·61
Sandy .	8·23	15·96	69·42	3·46	2·93	8·95	15·40	70·38	2·90	2·34	8·48	15·24	70·51	3·13	2·64	8·88	15·40	70·16	3·11	2·45	8·63	15·50	70·13	3·15	2·59
Waverley .	6·86	14·71	72·23	2·89	3·31	7·23	15·72	71·81	2·77	2·47	—	—	—	—	—	7·81	14·49	72·41	2·77	2·52	7·30	14·97	72·19	2·81	2·73
Newmarket (Old Seed)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7·19	13·20	74·24	2·86	2·51	7·19	13·20	74·24	2·86	2·51
Banner .	6·28	15·43	72·71	2·86	2·72	7·26	15·99	70·67	2·95	3·13	7·15	13·43	73·44	2·85	3·13	7·96	14·01	72·83	2·30	2·90	7·16	14·66	72·50	2·74	2·94
Goldfinder .	6·28	14·50	73·97	2·97	2·28	5·97	15·19	73·12	3·02	2·70	6·61	13·28	74·94	2·88	2·29	8·07	13·37	72·76	2·76	3·04	6·73	14·08	73·71	2·90	2·57
Newmarket	6·55	13·68	73·79	2·76	3·22	6·78	15·26	71·48	3·16	3·32	6·75	13·71	74·13	2·75	2·66	6·70	13·18	74·72	2·89	2·51	6·69	13·96	73·54	2·89	2·92
Tartar King	—	—	—	—	—	6·46	15·28	72·60	2·94	2·72	—	—	—	—	—	6·92	14·24	73·66	2·77	2·41	6·64	14·76	73·19	2·85	2·56
Storm King	5·70	16·90	71·95	2·98	2·47	5·95	16·90	71·48	2·90	2·77	6·26	15·81	72·47	3·14	2·32	—	—	—	—	—	5·97	16·53	71·98	3·00	2·52

TABLE XVII.

Composition of Oat Kernels. Dry.

Average of Seven Varieties from Ross and Cromarty and Morayshire.

Variety.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.
Potato . . .	9·30	15·50	68·96	3·27	2·97
Sandy . . .	8·67	16·05	69·13	3·30	2·85
Banner . . .	7·08	14·47	72·92	2·84	2·69
Waverley . .	6·94	14·75	72·72	2·84	2·75
Goldfinder . .	6·93	14·27	73·28	2·96	2·56
Newmarket . .	6·62	14·27	73·57	2·91	2·63
Storm King . .	5·88	16·51	71·58	2·99	3·04

The Tables show that of the seven varieties tried in both counties, Potato and Sandy are the richest in the quality of oatmeal which they yield. They are decidedly richer than any of the other varieties in oil, and are also richer than any of the other varieties, except Storm King, in albuminoids. Storm King, though rich in albuminoids, is the poorest of all varieties in oil. The kernel of Potato oats is remarkably rich in oil. In both counties Potato oats are, on the average, richer in oil than any other variety. Several of the samples gave over 10 per cent. of oil, and the average of all the samples from both counties was 9·3 per cent. of oil. This is a very notable percentage of oil and is quite comparable with the amount found in a good sample of oil cake. Oatmeal made from such an oat as Potato is quite an oily food. Sandy is a food second to Potato in respect to oil and is slightly richer than Potato in albuminoids on the average. Taking oil and albuminoids together, Potato and Sandy are nearly equal to one another in richness. Of the less com-

mon varieties, only Hamilton and Excelsior give analyses comparable wich Potato and Sandy in oil and albuminoids. Of Excelsior only one sample, that from Navity, Ross-shire, was analysed. There are no figures, therefore, on which to base an average. Hamilton was not grown in the experiments in Morayshire, but was grown on all four farms in Ross and Cromarty. The results from all of these show this oat to be rich in both oil and albuminoids. We are, therefore, able to say with some confidence that Hamilton yields an oatmeal very similar to that yielded by Potato. All the other new varieties yield results distinctly poorer in oil than the old varieties, and, with the exception of Storm King, distinctly poorer in albuminoids also. On the other hand, these new varieties are richer than the old varieties in the less valuable constituent, starch. The results all through, in the case of both counties, are remarkably consistent. The oats grown in Morayshire do not show any superiority in composition to those grown in Ross and Cromarty. On the average, the Ross and Cromarty oats are a little richer in oil and a little poorer in albuminoids than the same varieties grown in Morayshire. But the differences are slight, and not sufficient to base any general conclusions upon.

Composition of Straw.

Analyses of samples of straw of seven varieties from Morayshire and of eight varieties from Ross and Cromarty were also made. Samples of straw were sent in from all three farms in Morayshire but from only two farms in Ross and Cromarty. Separate analyses were not made of the samples from each different farm, but the straws of each variety from the three different farms in Morayshire were mixed, and average samples to represent the average straw of each variety for that county drawn from the mixtures. Similarly the straws of each variety from the two farms in Ross which sent samples were mixed and average samples drawn. The mixing was done by chaffing the samples of straw and mixing the chaff thoroughly. From this mixed chaff the sample for analysis was taken. In the case of the Morayshire samples a mistake was made in the mixing of the

Goldfinder straw which spoiled this sample, and no analysis of it was made. This reduced the number of varieties from Morayshire to seven.

The analyses of the straws were made by the ordinary methods of food analysis. The moisture was determined in the air-dried chaffed straw and all the other determinations were made in the dry material, and are thus reduced to a common basis. The determinations made in the dry matter were the albuminoids, the fibre, the ash and the siliceous matter contained in the ash. The soluble carbohydrates, oil, and any other substances present are given in the column headed "Soluble Carbohydrates, etc.", in the Tables below, and were merely determined by difference. In judging of the quality of the straws, so far as that is shown by analysis, the important figures are those for the albuminoids and for the fibre. The higher the albuminoids and the lower the fibre, the better the straw. The fibre is not necessarily indigestible. In fact, a large part of the fibre will be digested in the case of animals accustomed to live on a fibrous diet, and especially in the case of ruminating animals. At the same time the amount of fibre gives a general indication of the value of straw, for, generally speaking, the whole of the constituents, including the albuminoids and soluble carbohydrates, will be less digestible and therefore less valuable, in proportion as the fibre is higher.

The following Tables give the analysis of the average samples of each variety from the farms in Morayshire (Table XVIII.), the analysis of the average samples from two farms in Ross and Cromarty (Table XIX.), and the average, derived from these two tables, of the varieties common to both counties (Table XX.) In all the Tables the varieties are arranged in order according to the percentage of albuminoids which they contain.

TABLE XVIII.

Composition of Oat Straw. Season 1903.

Mixed Samples from Three Farms in Morayshire.

Variety.	Moisture.	Dry Matter.				
		Albuminoids.	Crude Fibre.	*Ash.	Soluble Carbohydrates, etc., by Difference.	*Containing Siliceous Matter.
Potato . .	11·50	4·43	40·45	5·95	49·17	2·31
Storm King .	12·45	4·15	38·66	6·53	50·66	2·67
Sandy . .	12·05	4·05	41·25	6·43	48·27	3·14
Waverley .	11·77	4·01	41·45	6·89	47·65	2·89
Newmarket .	12·71	4·01	41·54	7·27	47·18	2·81
Banner . .	12·10	3·89	41·85	6·51	47·75	2·68
Siberian . .	11·31	3·75	42·30	7·41	46·54	3·46

TABLE XIX.

Composition of Oat Straw. Season 1903.

Mixed Samples from Two Farms in Ross and Cromarty.

Variety.	Moisture.	Dry Matter.				
		Albuminoids.	Crude Fibre.	*Ash.	Soluble Carbohydrates, etc., by Difference.	* Containing Siliceous Matter.
Goldfinder .	12·66	4·09	44·40	5·08	46·43	1·39
Banner . .	12·12	3·50	45·98	5·83	44·69	1·56
Sandy . .	12·86	3·32	45·15	5·60	45·93	1·78
Newmarket .	11·87	3·26	44·84	5·39	46·51	1·51
Waverley .	12·31	3·23	46·88	5·00	44·89	1·04
Storm King .	12·68	3·18	44·00	5·33	47·49	1·29
Hamilton .	11·52	3·09	45·62	5·39	45·90	1·51
Potato . .	12·24	2·81	47·12	4·97	45·10	1·26

TABLE XX.

Composition of Oat Straw. Season 1903.

Average of Samples from Morayshire, and Ross and Cromarty. Six Varieties.

Variety.	Moisture.	Dry Matter.				
		Albuminoids.	Crude Fibre.	*Ash.	Soluble Carbo-hydrates, etc., by Difference.	*Containing Siliceous Matter.
Banner . .	12·11	3·69	43·91	6·17	46·23	2·12
Sandy . .	12·45	3·68	43·20	6·01	47·11	2·46
Storm King .	12·56	3·66	41·33	5·93	48·28	2·09
Newmarket .	12·29	3·63	43·19	6·33	46·85	2·16
Potato . .	11·87	3·62	43·78	5·46	47·14	1·78
Waverley .	12·04	3·62	44·16	5·94	46·28	1·96

An examination of the above Tables will show that there are considerable differences between the straws from Morayshire and those from Ross and Cromarty. Not only is the order and relative merit of the different varieties quite different in the two cases, but every variety which is common to the two counties is of distinctly better quality in the case of Morayshire than in the case of Ross and Cromarty. The difference all through between the two counties is very marked. The Morayshire straws are distinctly richer than the Ross and Cromarty ones in albuminoids, and they are much less fibrous. While, therefore, there was little difference in quality between the samples of grain grown in the two counties the same is not at all true of the samples of straw.

Further it will be noticed that the relative percentages of albuminoids and fibre in the different varieties, and therefore the relative order of merit, are very different in the two counties. In Morayshire Potato oats are richest in albuminoids and there come at the top of the table. In Ross the same variety is poorest in albuminoids and comes at the bottom. Not only so, but in

Morayshire Potato oats are the second best variety so far as lowness in fibre goes, and as they are top in albuminoids may therefore be said to be, so far as is shown by analysis, one of the best two varieties for quality of straw. On the other hand, in Ross they are not only bottom in albuminoids, but they are also the most fibrous variety, and therefore come out absolutely the worst variety for quality of straw in this county. Again Banner, which is nearly at the top in Ross, is nearly at the bottom in Moray. It appears then that the conditions which favour production of quality of straw are different for different varieties of oats, and what is favourable to one variety may be unfavourable to another and *vice versa*. Thus in the cold damp season of 1903, Potato and Storm King were favourably affected in the fine dry climate of Morayshire, but unfavourably affected in the moister climate of Ross. It is curious that though the amount of albuminoids shown by the different varieties in each county (Tables XVIII. and XIX.), varies very much, when we take the average for the two counties (Table XX.), the different varieties are practically equal in albuminoids, all of them giving about 3·65 per cent. The differences between the varieties in the two counties practically neutralise one another.

It is remarkable that Storm King takes a high place in quality of straw. Contrary to expectation this variety is in both counties lowest in fibre. So that while it is on the average practically equal to the other varieties in albuminoids, it is considerably the least fibrous of all the varieties of straw.

We have to thank Mr. W. M. Findlay, N.D.A., for assistance in compiling the Tables, and Messrs. W. J. Profeit, M.A., B.Sc., and H. D. Welsh for their assistance in the analytical work.

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 3

REPORT

ON

SPROUTING SEED POTATOES

1905

BY

R. B. GREIG, F.H.A.S., F.R.S.E.

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NOTE OF ACKNOWLEDGMENT.

THE Governors of the College desire to thank the occupants of the farms named in the Report, who gave the use of their land for the purposes of the experiments and who incurred some trouble in their supervision and execution.

THE SPROUTING OF SEED POTATOES.

For many years the growers of early potatoes have been in the habit of storing their potato seed in trays or boxes in thin layers, in order that the tubers should sprout before being planted.

Sprouted sets will produce an earlier crop than ordinary sets provided the sprouts are uninjured in planting, and in the case of very early kinds will produce a heavier crop in a given time than unsprouted sets.

While the advantages of sprouting have for long been apparent to the gardener and early potato grower, it is only lately that the boxing and subsequent sprouting of late potatoes have been shown to be profitable.

With a view to discover if the sprouting of late potatoes in the comparatively late climate of the north-east of Scotland would be profitable, a test of sprouted *versus* unsprouted sets was made in 1905, at nine centres.

The trial was a preliminary one, arranged in connection with a different and larger experiment at the same centres and it was not intended to report specially upon it. The results, however, have been so much and so uniformly in favour of sprouting that it is considered worth while to publish them in spite of the small area utilised for each test at each centre and the small quantity of seed planted. Between 7 and 8 cwts. of sprouted sets have been compared with 7 or 8 cwt. of unsprouted sets, and seven varieties of potatoes have been tested at nine centres over a total area of more than an acre, and the correspondence of results from so many places with so many varieties neutralises the probability of error due to the small area of each single plot.

The trials were made on the farms mentioned below, and in addition to the seed provided by the College, a variety generally grown by the experimenter was put in the test. The "home seed" used at each place is noted in the list.

TABLE I.

FARMS AT WHICH THE TRIALS WERE CARRIED OUT.

OCCUPIER.	FARM.	DISTRICT.	HOME SEED USED.
Mr. Wm. Blair . .	West Mathers	St. Cyrus .	Empress Queen.
* Mr. D. Anderson .	North Loirston	Nigg . .	Up-to-Date.
Aberdeen City District Lunacy Board . .	Kingseat . .	Newmachar .	Up-to-Date.
Mr. John Watt . .	Watermill .	Fraserburgh .	Dalmeny Beauty.
Mr. J. K. Ledingham .	Fintry . .	Turriff . .	Abundance.
Mr. J. O. Morrison .	Tipperty . .	Banff . .	Maincrop.
Mr. W. Rose Black .	Sheriffston .	Elgin . .	Up-to-Date.
Mr. G. A. Ferguson .	Surradale .	Elgin . .	Up-to-Date.
Mr. John Gordon .	Cullissee . .	Nigg, Ross-shire	Factor.

The first six varieties in Table II. were obtained from Dolphingstone, Midlothian, where they had been grown. Twenty-eight lbs. of each variety were sent to each experimenter and 14 lbs. were sprouted in the usual way in trays or boxes provided for the purpose; the remainder of the sets were retained unsprouted. The boxing was begun in February or March so that in some cases the sets had less than eight weeks to grow before being planted. The results are all the more striking in view of this short period. As a rule the same number of sets were planted, and in one case exactly the same weight and number. The manuring conditions

* The results at North Loirston are not included in the averages owing to insufficient data. There was a gain by sprouting most of the varieties but the difference was slight.

were exactly similar at each centre but would of course vary considerably between one centre and another.

The sets were all planted on the same day at the usual time for planting potatoes in the district where a trial was made and the resulting crops were lifted on the same day.

TABLE II.

Showing Average Total Produce of Potatoes from Sprouted and Ordinary Seed from each Variety and the Total Gain by "Sprouting".

	Sprouted.		Unsprouted.		Gain by Sprouting.	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
King Edward VII. . .	12	5¾	9	4½	3	1¼
Evergood	11	12	9	4½	2	8½
Up-to-Date	12	11	10	8	2	3
Northern Star . . .	12	6½	10	7¼	1	19¼
Royal Kidney . . .	12	0	10	1½	1	18½
British Queen . . .	11	0⅝	10	0	1	0⅝
Home Seed	11	12¾	10	14½	0	18¼

From the table above it is clear that on the average the sprouted tubers have given a great increase of crop. Unless, however, the individual plots corroborate each other the average cannot be considered trustworthy. As seven varieties were tried at eight centres there were fifty-six plots planted with sprouted and fifty-six with unsprouted tubers. In forty-seven trials the sprouted produced from 18 cwts. to 3 tons more than the unsprouted, and in the remaining trials the unsprouted gave less—in most cases very little less—than the sprouted. On four of the farms all the varieties gave a large increase from sprouting, on the remaining farms, one or two kinds, usually the home seed, did rather better when unsprouted.

TABLE III.

Showing the Average Produce of Marketable Potatoes and the Gain of Marketable Potatoes by "Sprouting".

	Sprouted.		Unsprouted.		Gain by Sprouting.	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
King Edward VII. . . .	10	8¾	7	5	3	3¾
Up-to-Date	11	1¾	8	7½	2	14¼
Evergood	9	5½	6	17¾	2	7¾
Northern Star . . .	9	5¾	6	19½	2	6¼
Royal Kidney . . .	9	2¾	6	17¼	2	5½
Home Seed	9	19¼	8	3¼	1	16
British Queen . . .	8	19¾	7	8¾	1	11

Marketable Potatoes.

When the comparison is made between the quantities of "Marketable" potatoes obtained by each system the returns are even more favourable to sprouting. It is apparent that the start given to the sprouted sets enabled them to produce larger tubers although the crops occupied the ground the same number of days.

If the last column of Table II. is compared with the last column of Table III., it will be seen that the gain of marketable potatoes by sprouting is relatively greater from the varieties Royal Kidney and British Queen and from the home seed. It also appears that some varieties repay the trouble of sprouting better than others.

TABLE IV.

Showing the Percentage of Small and Diseased Potatoes.

	Average per Cent. of Small Potatoes.		Average per Cent. of Diseased Potatoes.	
	Sprouted.	Unsprouted.	Sprouted.	Unsprouted.
British Queen . .	10·5	17·2	1·5	5·6
Up-to-Date . .	6·4	8·8	1·8	3·2
King Edward VII. .	8·9	15·3	—	—
Royal Kidney . .	15·7	22·6	—	—
Northern Star . .	14·8	20·9	1·3	2·3
Evergood . . .	11·6	16·7	—	—
Home Seed . .	8·5	14·8	—	—

The Effect of Sprouting on Size and Disease.

The effect of the sprouting on the size of the tubers and the proportion of diseased potatoes is well brought out by the figures in Table IV., where the percentage of small potatoes is seen to be invariably less where sprouted tubers have been used.

Diseased potatoes were also less abundant among the sprouted to the extent of 2 or 3 per cent. In only three of the varieties was there any disease worth noting.

Effect of Sprouting in Different Districts.

It is noticeable that the largest returns from sprouting are obtained in the latest districts. Newmachar, near Aberdeen, is a week or ten days later than any of the other places, and here the gain by sprouting is over four tons. In the finer climate of Banffshire and Morayshire, on the seaboard of the Moray Firth, the returns are less, and at Cullissee, in a warm and sheltered situation on the shores of the Cromarty Firth, the gain is least.

TABLE V.

SHOWING THE GAIN BY SPROUTING IN DIFFERENT DISTRICTS.

	Tons.	Cwts.
KINCARDINESHIRE—		
West Mathers, St. Cyrus	3	0½
ABERDEENSHIRE—		
Fintry, Turriff	1	13½
Watermill, Fraserburgh	3	13¾
Kingseat, Newmachar	4	5¾
MORAYSHIRE—		
Surradale, Elgin	1	17⅛
Sheriffston	2	1
BANFFSHIRE—		
Tipperty, Banff	1	18¾
ROSS-SHIRE—		
Cullissee, Nigg	—	10

THE CROPPING POWER OF THE VARIETIES.

The crops obtained from the different kinds were large and very uniform. Of the newer varieties, Northern Star and King Edward VII. were on the whole the heaviest croppers, and less affected by disease than Up-to-Date and British Queen.

It may be fairly assumed from these trials that this system is likely to prove advantageous with late varieties and in a late district in a year like 1905. The advantages of sprouting may be summarised as follows:—

1. In a normal year the crop is heavier.
2. There are fewer small and more saleable tubers from sprouted sets.
3. In a late spring sprouted sets may be planted late without a reduction of crop.

4. Where autumn frosts occur little damage will be done, as the potatoes from sprouted sets will be more mature.

5. A crop from sprouted sets may be raised sooner than a crop from ordinary sets.

The disadvantages are perhaps equally obvious.

1. There is first the initial cost of the boxes. Potatoes will sprout on a floor or in any kind of box, but the most convenient size of box is 24 inches long, 12 inches wide, and 3 inches deep, with corner pieces 7 inches high, so that the boxes can be piled on each other to any height without interfering with ventilation. It is of importance that there should be a cross handle fixed into the side pieces for convenience of carrying. Such boxes will hold about 20 lbs. of potatoes, and can be purchased in Aberdeen at 30s. per 100.*

As 100 boxes are sufficient for one acre and the boxes will last several years with ordinary care, the cost is spread over, say, six years, and is therefore 5s. per acre.

2. A storage space is a difficulty where a large area is planted, but where only a few acres are grown, or on crofts, the boxes may be stored on the couples of the byres or cattle sheds, and the sets will do quite well there.

3. More labour is required at planting, but the difference as compared with the ordinary method is very little, and where the boxes described above are used it is scarcely appreciable.

Treatment of the Sets.

The potatoes for seed may be placed in the boxes when lifted in the autumn, or they may be removed from the pits any time in winter. They require no arrangement, but are simply scattered in the boxes in one or two layers, without earth. When the sprouts are about 2 inches long, growth may be stopped and the sprouts toughened by exposure to light. When hardened in this manner the sprouts do not break off easily and the sets may be dropped in the drills in any position. It is not advisable to cut sprouted sets, and the best size for boxing is about $1\frac{1}{2}$ inches, or what would pass through a $1\frac{3}{4}$ inch riddle, and be retained by a $1\frac{1}{4}$ inch riddle.

* Mr. Lyon, Box Manufacturer, North Esplanade, Aberdeen, can supply particulars of the boxes described above.

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 4

REPORT

ON

TURNIP EXPERIMENTS

1904-5

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THE ABERDEEN UNIVERSITY PRESS LIMITED
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ANALYSES OF MANURES.

The following are the analyses of the manures used in these experiments:—

	Per Cent.
Sulphate of Ammonia—	
Nitrogen	20·28
Equal to Ammonia	24·63
Equal to Sulphate of Ammonia	95·63
Bone Meal—	
Nitrogen	3·72
Equal to Ammonia	4·51
Phosphates as Tri-Basic Phosphate of Lime	52·02
Equal to Phosphoric Acid	23·83
Fineness: 6·16 per cent. failed at a sieve of $\frac{1}{10}$ inch mesh. 42·80 per cent. passed a sieve of $\frac{1}{10}$ inch mesh, but failed at a sieve of $\frac{1}{30}$ inch mesh.	
Superphosphate—	
Soluble Phosphate as Tri-Basic Phosphate of Lime	33·16
Equal to Phosphoric Acid	15·19
Insoluble Phosphate as Tri-Basic Phosphate of Lime	1·77
Improved Superphosphate—	
Soluble Phosphate as Tri-Basic Phosphate of Lime	33·12
Equal to Phosphoric Acid	15·17
Insoluble Phosphate as Tri-Basic Phosphate of Lime	1·74
Basic Superphosphate—	
Total Phosphate as Tri-Basic Phosphate of Lime	31·49
Equal to Phosphoric Acid	14·42
Phosphate as Tri-Basic Phosphate of Lime soluble in dilute Citric Acid Solution (1 in 1000)	29·74
Equal to Phosphoric Acid	13·62
Florida Phosphate (Dunellan)—	
Phosphate as Tri-Basic Phosphate of Lime	77·62
Equal to Phosphoric Acid	35·55
Fineness: 89·25 per cent. passed a sieve of $\frac{1}{100}$ inch mesh.	
Sulphate of Potash—	
Potash	51·39
Equal to Potassium Sulphate	95·10

NOTE OF ACKNOWLEDGMENT.

Thanks are due to the occupants of the farms named in the Report, who gave the use of their land free of charge, for the purposes of the experiments, and who incurred much trouble and some expense in their supervision and execution.

TURNIP EXPERIMENTS, 1904.

The series of field trials and experiments on the Manuring of Turnips, the Analyses of Soils and the Composition of Varieties of Turnips and Swedes, inaugurated in 1903, were continued at twenty-six centres in the North and North-East of Scotland in 1904.

The experiments which form the subject of this Report are dealt with in the following order:—

(*a*) The manuring of the turnip crop.

(*b*) The chemical and mechanical analyses of soils experimented on.

(*c*) The composition of turnips.

The Season.

The season was in almost all districts entirely favourable to the turnip crop, and the comparative absence of "finger and toe" and complete absence of turnip "fly" allowed the production of a more than average crop. A small beetle (Ceutorhynchus) did some damage to the cotyledon leaves in June, the grub of a fly (Anthomyia brassicæ) killed a few plants later in the season, and in September and October the Turnip Mud Beetle (Holophorus Rugosus) made an almost unprecedented attack on the base of the leaves and on the upper parts of the bulbs of both turnips and swedes. The fine weather, however, had given the crops a size and stamina which enabled them to withstand the pests, and, except perhaps in the Turriff district and in one or two smaller areas, no great damage was done. The difference between the seasons of 1903 and 1904 is well illustrated by comparing the produce of Plots 1 and 2 in each year.

		1903.		1904.	
		Tons.	Cwt.	Tons.	Cwt.
Plot 1.	No Manure . .	3	18	9	14¼
Plot 2.	Complete Manure .	12	10	20	8¾

Report on Manuring Experiment.

Manurial trials were carried out at the nineteen centres named below.

TABLE I.

Stations at Which the Experiments were Carried Out.

No.	Farm.	Occupier.	Description of Land.	Previous Cropping.
1	Mains of Fasque Fettercairn	Sir John R. Gladstone per Mr. A. Dewar	Clay loam on clay subsoil	Oats after lea.
2	Kincraigie, Lumphanan	Mr. A. Calder . .	Sandy loam on gravel subsoil	,,
3	Johnstone, Leslie, Insch	Mr. W. J. Chrystall .	Sandy loam on sandy subsoil	,,
4	Greystone, Alford . .	Mr. Harry Forbes .	Light sandy loam on rock subsoil	,,
5	Craighall, Kennethmont	P. A. Grant, Esq. .	Sandy loam . .	,,
6	Mains of Drum, Maud .	Mr. W. Irvine . .	Light sandy soil on hard-pan and rock	,,
7	Dorsencilly, Ballater .	Mr. A. McHardy .	Sandy loam over gravel	,,
8	East Kinharrachie, Ellon	Mr. Robt. Middleton	Medium loam on red moor-pan	,,
9	Mains of Fisherie, King Edward	Mr. Geo. Lawson .	Deep rich loam on gravelly subsoil	,,
10	Rettie, Banff . . .	Mr. A. Forbes . .	Light loam on hard iron pan	,,
11	Mills of Rathven, Buckie	Messrs. W. & A. McLean	Light strong loam on hard iron pan	,,
12	Dandaleith . . .	Mr. F. Baxter . .	Sandy loam . .	,,
13	Collargreen, Craigellachie	Mr. A. Young . .	Deep loam . . .	Potatoes.
14	Mounteagle, Fearn .	Mr. W. Robertson .	Peat	Oats after lea.
15	Insh, Avoch . . .	Mr. A. Matheson .	Medium loam . .	,,
16	Hillhead, Kintore . .	Mr. A. Henderson .	Light loam on hard iron pan	,,
17	Redford, Park . .	Mr. W. Taylor . .	Sandy loam . .	,,
18	Stonebriggs, Rosehearty	Mr. A. S. Morrison .	Deep sandy loam .	,,
19	Newton, Cromarty .	Mr. J. E. Scott .	Deep loam on old red sandstone	,,

The trial comprised fifteen plots at each farm, each plot was one-sixteenth of an acre in extent, and the central drills (equal

to one-twentieth of an acre) were weighed. The plots were measured, the manures were sown, and the produce was weighed under the superintendence of representatives from the College. All the centres were inspected at least once during the growth of the crops, and copious notes were taken of the condition of the soil, the appearance of the plants, the prevalence of "canker," etc.

The Objects of the Experiments.

The objects of the experiments were explained in Bulletin No. 1, but we may repeat that, in the first place, it was desired to demonstrate the importance of knowing the manurial peculiarities of a soil, and, in the second place, to discover, if possible, the connection between the effects of the manurial applications and the mechanical and chemical composition of the soil as shown by mechanical and chemical analyses.

The Five-Plot Test.

What does the Soil require?

Five plots are necessary for this test, in which one of the three essential plant food materials are in turn omitted from the mixture of manures. By comparing the weight of crop obtained when potash, for example, is omitted, with the crop resulting from a complete dressing, the value of potash on the soil experimented on is indicated. Assuming that potash is exceptionally deficient on a certain soil, our object is to ascertain if this deficiency could have been forecasted by analyses.

The "five-plot test" which must thus precede the analysis is a familiar one to every agriculturist who is conversant with modern field trials, and in the case of the turnip crop the average result of the test is a foregone conclusion, for it is certain that where sufficient trials are made more than half will show the predominating importance of the phosphate supply.

In 1904 the farms which are "phosphate hungry" are just twice as numerous as those which are "potash hungry," *i.e.*, twelve to six, and in no instance is "nitrogen hunger" evidenced by the test. The following table shows the farms separated into their classes according to their requirements, and the loss incurred by the omission of their most necessary plant food material.

TABLE II.

Showing the Farms "A" at which Phosphates are the Most Essential Plant Food, and "B" where Potash is Chiefly Required, and the Loss Incurred by the Omission of the Most Necessary Constituent.

"A" Farms (Phosphate Hunger).	Loss of Crop Due to Want of Phosphates.			"B" Farms (Potash Hunger).	Loss of Crop Due to Want of Potash.		
	Tons.	Cwt.	Lb.		Tons.	Cwt.	Lb.
Greystone . .	6	19	8	Johnstone . .	3	12	10
Stonebriggs . .	5	3	9	Insh	3	6	4
Mounteagle . .	5	10	8	Kincraigie . .	2	15	4
Redford . . .	4	12	9	Dorsencilly . .	2	7	4
Rettie . . .	3	17	4	Mills of Rathven .	1	18	6
Craighall . . .	3	16	1	Collargreen . .	0	7	10
East Kinharrachie .	3	8	5				
Mains of Fisherie .	3	1	2				
Fasque . . .	2	19	7				
Hillhead . . .	2	4	7				
Mains of Drum .	1	17	2				
Dandaleith . .	1	6	7				

When the farms in one division are compared with those in another no striking difference is apparent. On the whole, the A farms, which require phosphate, have lighter, sharper and hungrier soils than the B farms, which require potash. The A farms are naturally poorer land or in lower condition than the B farms, for the average crop grown without manure on the first is 7 tons per acre as compared with 12 tons on the second. It was noticeable in the 1903 trials that the best land (deep alluvial soil on Donside) was deficient in potash, and in 1904 the only alluvial station on Deeside was also found to be deficient in potash. On several farms the want of potash is as clearly indicated by the soil analyses as by the manurial trials (see page 25).

For the sake of the reader of averages the financial aspect of the "five-plot test" is placed below in the usual form :—

TABLE III.

SHOWING THE AVERAGE LOSS DUE TO WANT OF POTASH, PHOSPHATES AND NITROGEN RESPECTIVELY ON EIGHTEEN FARMS (PER ACRE).

PLOT.	APPROXIMATE QUANTITY OF MANURES PER ACRE.	AVERAGE YIELD.		INCREASE DUE TO MANURES.		COST OF MANURES.		PROFIT OR LOSS.	
		Tons.	Cwt.	Tons.	Cwt.	s.	d.	s.	d.
1	No Manure	9	1	—		—		—	
2	⅞ cwt. Sulphate of Ammonia 5¾ cwt. Superphosphate ¾ cwt. Sulphate of Potash	20	7½	11	6½	37	11	+ 52	8
3	⅞ cwt. Sulphate of Ammonia 5¾ cwt. Superphosphate No Potash	16	3	7	2	30	3	+ 26	9
4	⅞ cwt. Sulphate of Ammonia ¾ cwt. Sulphate of Potash No Phosphates	11	4½	2	3½	19	6	– 1	10
5	5¾ cwt. Superphosphate ¾ cwt. Sulphate of Potash No Nitrogen	18	17	9	16	27	1	+ 51	0

COMPARATIVE VALUE OF PHOSPHATIC MANURES.

In the previous Report it was shown that superphosphate and slag were more profitable fertilisers than bone meal and ground Florida phosphate. The comparison was made by applying equal

quantities of phosphoric acid from each of the four sources of phosphate, and as ground Florida phosphate contains a greater proportion of total phosphates than bone meal, superphosphate or basic slag, only $2\frac{1}{4}$ cwt. of the first was used against from 3 to 5 cwt. of the last three. Ground Florida phosphate is also cheaper per unit of phosphate than any other source of phosphate, and, therefore, in planning the 1904 experiments we decided, in order to place the mineral phosphate on more equal terms with the others, to use the more impressive method of "equal money values". The market price of phosphatic manures fluctuates, but the price of each manure in relation to the others remains fairly constant, so the comparison is a practical if not a scientific one, and shows the pecuniary aspect of the test with clearness.

In addition to the four phosphatic manures already tested a mixture of superphosphate and slag was used, and two recently introduced fertilisers, *viz.*, improved superphosphate and basic superphosphate. The former is a prepared superphosphate containing, it is claimed, no free sulphuric acid and in drier condition than the ordinary; the latter is made by adding slaked lime to good superphosphate, and both are manures intended to replace superphosphate on land subject to "finger and toe". As "canker" or "finger and toe" was almost absent from the plots the preventive action of these fertilisers has not been sufficiently tested, but from the context it will be seen that their manurial effects are good.

The standard dressing used as a basis of comparison in this section of the trials was composed of 20 lb. of nitrogen, supplied by sulphate of ammonia; 40 lb. of potash, supplied by sulphate of potash, and 100 lb. of phosphoric acid, supplied by superphosphate. One hundred pounds of phosphoric acid are contained in $5\frac{3}{4}$ cwt. of the superphosphate used, therefore the remaining plots received the amount of phosphatic manure that could be purchased for the price of $5\frac{3}{4}$ cwt. of superphosphate.

The average results of the trial are set forth on Table IV.

TABLE IV.

PHOSPHATIC MANURES COMPARED SHOWING THE RELATIVE PROFIT DUE TO THE DIFFERENT PHOSPHATIC MANURES TESTED (15 FARMS).

PLOT.	APPROXIMATE QUANTITIES OF MANURE PER ACRE.	AVERAGE YIELD.		INCREASE DUE TO MANURES.		PROFIT.	
		Tons.	Cwt.	Tons.	Cwt.	s.	d.
1	No Manure	9	5	—		—	
2	⅞ cwt. Sulphate of Ammonia 5¾ cwt. Superphosphate ¾ cwt. Sulphate of Potash	20	5	11	0	50	0
10	4¾ cwt. Bone Meal ¾ cwt. Sulphate of Potash	18	0	8	15	32	0
11	⅞ cwt. Sulphate of Ammonia 6⅜ cwt. Basic Slag ¾ cwt. Sulphate of Potash	20	4	10	19	49	8
12	⅞ cwt. Sulphate of Ammonia 6⅛ {cwt. Superphosphate cwt. Basic Slag ¾ cwt. Sulphate of Potash	20	13	11	8	53	3
13	⅞ cwt. Sulphate of Ammonia 4⅞ cwt. Ground Florida Phosphate ¾ cwt. Sulphate of Potash	16	18	7	13	23	3
14	⅞ cwt. Sulphate of Ammonia 5¾ cwt. Improved Super ¾ cwt. Sulphate of Potash	19	17	10	12	46	10
15	⅞ cwt. Sulphate of Ammonia 4⅞ cwt. Basic Superphosphate ¾ cwt. Sulphate of Potash	18	18¼	9	13	39	4
16	10 cwt. New Fertiliser . .	14	4	4	19	5	0

The comparative values of the phosphatic manures are best shown by an estimate of the loss incurred when another manure is used instead of a mixture of superphosphate and basic slag, but in the first three the differences are too small to be regarded as guides to their relative value.

When Superphosphate is used the loss is approximately	1s.	9d.
,, Basic Slag is used the loss is	3s.	4d.
,, Improved Superphosphate is used the loss is .	6s.	5d.
,, Basic Superphosphate is used the loss is . .	13s.	7d.
,, Bone Meal is used the loss is	20s.	11d.
,, Ground Florida Phosphate is used the loss is .	29s.	8d.

Ground Florida Phosphate or Coprolites.

Consideration of the tabulated results shows the undeniable inferiority of ground Florida phosphate, even on the new basis. Analysis of the individual returns brings out the fact that ground Florida phosphate has produced the smallest crop at twelve centres in seventeen, and at the remaining five it has yielded the smallest crop but one. In the former trials it was used with nitrate of soda, in these with sulphate of ammonia, and in both it has proved unprofitable.

Bone Meal.

In the first Report it was shown that the loss incurred by using bone meal instead of superphosphate was equal to 28s. 3d. per acre. In 1904 we find again that the popularity of bone meal is not justified by experiment. On five farms it has grown the smallest crop and on other five farms the second smallest crop, and in no single instance has it produced the largest crop. It is possible that the popularity of bone meal is due to indirect and compensating advantages. For example, it may produce sounder and better keeping roots in a year of "canker"; it may produce better turnips for feeding purposes, and its residual effects may be greater, though the evidence of other experimenters does not on the whole bear this out.

Basic Superphosphate and Improved Superphosphate

Proved themselves useful fertilisers apart from possible effects in preventing "finger and toe," but both were inferior to super and slag as crop producers. Dandaleith and Craighall were the only centres at which "finger and toe" seriously affected the crop, and at the former all the plots were equally affected, while at the latter the plots receiving basic slag and a mixture of basic slag and super showed less disease than those to which improved super and basic super had been applied. Therefore, so far as our evidence goes, there is nothing to show that improved super and basic super are worth the extra price asked for them. On the whole improved superphosphate has a slight advantage over basic superphosphate, and at Insh in the Black Isle, on the old red sandstone, and at Johnstone, Leslie, it was considerably superior to any other phosphatic manure. It is noteworthy that these two farms suffer from potash hunger to a marked degree.

Super *versus* Slag.

This comparison, which has been made in most parts of the country many times, ends as usual by demonstrating the fractional superiority of superphosphate as a turnip grower, but for all practical purposes, if the better quality of slag-grown roots is set against the slightly larger crop due to super, the two fertilisers are on an equal footing. On peaty soil and on soils poor in lime basic slag will as a rule prove more effective, and that is well brought out by the trial at Mounteagle where on a black peaty soil, slag and a mixture of slag and super, were clearly superior to superphosphate alone.

A Mixture of Super and Basic Slag.

When in doubt use both, is apparently sound policy judging by these trials, as a mixture of slag and super has produced the largest and most profitable average crop.

The "New Fertiliser".

A patent proprietary manure called the "New Fertiliser" and sold at £3 10s. per ton was being widely advertised in the North of Scotland. It is claimed that owing to a secret process of manufacture it is more certain and reliable in its action than any other kind of manure. As we had some previous experience of this manure and did not find it specially useful we resolved to test it against the manures already described. An equal money value was therefore applied at Johnstone, Greystone, Rettie and Hillhead. At the two former centres it produced the smallest crop in its class, and at the two latter places the second smallest crop. Although it has some manurial value it is inferior to, and much less profitable than, most of the mixtures against which it was tried.

Phosphatic Manures Along with Dung.

At Redford and Hillhead 10 tons of dung were applied to the plots by which the phosphatic manures were compared, and it will be seen from a consideration of the figures in Table VII. that with dung, as without it, bone meal and ground mineral phosphate are still inferior and super and slag still superior.

Artificial Manures Along with Dung.

In Bulletin No. 1 it was pointed out that the almost universal practice of applying artificial manures to the turnip crop was not always directly profitable, if a complete manure was used. In 1903 the season was a bad one for the turnip crop, and the range of increase over the plots receiving no manure was small. In 1904, in a good season, the range (see page 18) was much greater, the manures had an opportunity to produce fuller effects, with the result that applications which resulted in a loss in 1903 gave a profit in 1904.

Plots 7, 8 and 9 received the dressings stated in the table below, from which it may be seen that a substantial profit has resulted from the use of the artificial manures along with dung.

The smaller dressing has given the larger profit, but it is certain that the effects of the manures are not exhausted in the first year, and the profits from the larger dressing may in the end eclipse the smaller. Below (Table V.) are the results from seventeen centres and the amount of crop required to pay for the artificial manures, so that a glance will show whether or not the dressing has paid.

TABLE V.

EFFECTS OF MEDIUM AND SMALL DRESSINGS OF ARTIFICIAL MANURES ALONG WITH DUNG. AVERAGE RESULTS PER ACRE (17 FARMS).

Plot.	Manure.	Average Yield.		Increase Due to Artificial Manure.		Cost of Artificial Manure.		Profit.	
		Tons.	Cwt.	Tons.	Cwt.	s.	d.	s.	d.
7	10 tons Dung	17	$10\frac{1}{4}$	—		—		—	
8	10 tons Dung . . . $\frac{7}{8}$ cwt. Sulphate of Ammonia $5\frac{3}{4}$ cwt. Superphosphate $\frac{3}{4}$ cwt. Sulphate of Potash	22	$12\frac{1}{2}$	5	$2\frac{1}{4}$	37	11	2	11
9	10 tons Dung . . . $\frac{7}{16}$ cwt. Sulphate of Ammonia $2\frac{7}{8}$ cwt. Superphosphate $\frac{3}{8}$ cwt. Sulphate of Potash	20	$15\frac{1}{2}$	3	$5\frac{1}{4}$	19	0	7	1

Individual Results.

Centre.	Increase Due to			
	8 Cwt. Artificials. Plot 8.		4 Cwt. Artificials. Plot 9.	
	Tons.	Cwt.	Tons.	Cwt.
Insh	12	14	8	4½
Dandaleith	5	16¾	3	12¼
Mains of Fisherie	5	10	2	4
East Kinharrachie	7	15½	5	0¾
Mains of Drum	7	17¾	4	9
Craighall	7	5½	6	11½
Fasque	9	0	7	0
Mounteagle	5	8	6	9¼
Collargreen	3	14	1	8½
Greystone	3	15¾	0	9
Johnstone	3	8	3	7½
Rettie	3	6	1	11½
Kincraigie	2	18	1	4
Dorsencilly	2	13¼	1	6½
Mills of Rathven	1	17½	0	1½
Redford	2	4	1	12
Hillhead	0	16½	1	19*
Increase required to pay for the Artificial Manures	3	4	1	12

Large *versus* Smaller Dressings of Dung.

Plots 6 and 7 deal with the effects of large as compared with smaller dressings of dung, and it will be noticed from Table VI. that the effects of 5 extra tons of dung are not in proportion to the dressing.

* Decrease.

TABLE VI.

Effects of Increasing the Dressing of Dung.

Plot.		Average Yield.		Increase Due to 5 Tons.	
		Tons.	Cwt.	Tons.	Cwt.
1	No Manure	9	4¾	—	
7	10 tons Dung	18	3½	—	
6	15 tons Dung	19	14	1	11½

While 10 tons of dung have nearly doubled the crop, 5 extra tons have produced a further increase of only 31 cwt.

The late Dr. Aitken, after conducting thirty experiments in Banffshire, in a year particularly favourable to farmyard manure, pointed out the comparatively poor effects of large dressings of dung, and suggested that dividing the available quantity of dung over the other crops of the rotation was likely to be more profitable (*Transactions of the Highland and Agricultural Society of Scotland*, 1894, p. 439). To divide the dressing involves some practical difficulties, and until certain rotation experiments now in progress are completed it is inadvisable to make statements with regard to the result of such a procedure, but it is worth while to point out that, apart from the possibility of larger crops, a change in the method of using the foldyard manure might result in freedom from "finger and toe". At Craighall in the 1904 experiments (Bulletin No. 1) the prevalence of "finger and toe" was in proportion to the quantity of dung applied. On Plot 7, which received the larger dressing, the disease was very bad; on Plot 8, with a smaller dressing, there was much less, and on some of the plots which were dressed with artificials only, no disease appeared. Acting on this indication Mr. Grant, in 1905, grew a crop of turnips at Craighall with artificial manures only and careful inspection could discover no "finger and toe".

On another field, to part of which dung had been applied, the disease was found on the dunged area and practically no disease on the rest of the field. In 1904 "finger and toe" showed itself at two stations, and only on the dunged plots. If the turnip crop on land subject to "finger and toe" were grown with artificial manures and the dung applied to other crops of the rotation without loss, much larger and healthier root crops would probably result. This method has been in operation on one or two farms in the North of Scotland for several years with great success. If there are some still doubtful of the possibility of growing a full crop of roots with artificial manures alone, the following statement should reassure them:—

	Tons.	Cwt.
10 tons dung alone in 1904 experiments produce an average crop of	18	3½
8 cwt. artificial manures produce an average crop of .	20	7½

The Abuse of Ground Lime.

The practice of applying ground lime in the drill shortly before the turnips are sown, while it may in some cases decrease the "finger and toe" disease, will in most cases cause a considerable diminution in the crop. In 1903 the application of 10 cwt. ground lime increased the crop at one centre only, at the remaining stations it decreased the crop from 6 to 7 cwt., and in a special experiment at Fasque it caused a loss of 5 tons 2 cwt.

In 1904 the application of lime on another field at Fasque again decreased the crop by 4 tons 15 cwt.

Summary.

In the North of Scotland potash is more important than nitrogen as a food material for the turnip crop, and even on good land in high condition it may be the most essential ingredient.

Superphosphate and basic slag, or a mixture of these, are on the average the most profitable sources of phosphoric acid.

Bone meal and ground mineral phosphates are not directly profitable in comparison with the above-mentioned fertilisers.

So far as our evidence shows, improved superphosphate and basic superphosphate have no advantage over superphosphate and basic slag.

Patent proprietary manures should be purchased with caution and used with discretion till proved by experiment.

In a good year a complete dressing of artificial manures in medium quantity along with 10 tons of dung leaves a satisfactory profit.

More than 10 tons of dung does not produce a proportionate increase of crop.

On land subject to "finger and toe" dung encourages the disease in proportion to the quantity applied.

Ground lime applied when the turnips are sown, generally decreases the crop.

In conclusion the reader is strongly advised not to judge by averages alone, but to study the results from the farms with which he is familiar. The complete details from all stations are given in Table VII., p. 18.

We have pleasure in acknowledging the assistance of Mr. W. A. Findlay, N.D.A., who compiled most of the Tables, and Mr. T. H. Gibson, who supervised a number of the trials.

TABLE VII.

SHOWING THE KINDS AND QUANTITIES OF MANURES APPLIED, THE WEIGHT OF PRODUCE OBTAINED ON EACH PLOT, THE COST OF MANURES, THE INCREASE RESULTING FROM THEIR APPLICATION AND THE PROFIT PER ACRE.

Number of Plot.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
Approximate Quantity of Manures Applied Per Acre.	No Manure.	$\frac{7}{8}$ Cwt. Sulphate of Ammonia; $5\frac{3}{4}$ Cwt. Superphosphate; $\frac{3}{4}$ Cwt. Sulphate of Potash.	$\frac{7}{8}$ Cwt. Sulphate of Ammonia; $5\frac{3}{4}$ Cwt. Superphosphate.	$\frac{7}{8}$ Cwt. Sulphate of Ammonia; $\frac{3}{4}$ Cwt. Sulphate of Potash.	$5\frac{3}{4}$ Cwt. Superphosphate; $\frac{3}{4}$ Cwt. Sulphate of Potash.	15 Tons Dung.	10 Tons Dung.	10 Tons Dung; $\frac{7}{8}$ Cwt. Sulphate of Ammonia; $5\frac{3}{4}$ Cwt. Superphosphate: $\frac{3}{4}$ Cwt. Sulphate of Potash.	10 Tons Dung; $\frac{7}{16}$ Cwt. Sulphate of Ammonia; $2\frac{1}{8}$ Cwt. Superphosphate; $\frac{3}{8}$ Cwt. Sulphate of Potash.	$4\frac{3}{4}$ Cwt. Bone Meal; $\frac{3}{4}$ Cwt. Sulphate of Potash	$\frac{7}{8}$ Cwt. Sulphate of Ammonia; $6\frac{2}{3}$ Cwt. Basic Slag; $\frac{3}{4}$ Cwt. Sulphate of Potash.	$\frac{7}{8}$ Cwt. Sulphate of Ammonia; $2\frac{7}{8}$ Cwt. Super; $3\frac{3}{16}$ Cwt. Slag; $\frac{3}{4}$ Cwt. Sulphate of Potash.	$\frac{7}{8}$ Cwt. Sulphate of Ammonia; $4\frac{6}{7}$ Cwt. Florida Phosphates; $\frac{3}{4}$ Cwt. Sulphate of Potash.	$\frac{7}{8}$ Cwt. Sulphate of Ammonia; $5\frac{3}{4}$ Cwt. Improved Super; $\frac{3}{4}$ Cwt. Sulphate of Potash.	$\frac{7}{8}$ Cwt. Sulphate of Ammonia; $4\frac{6}{7}$ Cwt. Basic Super; $\frac{3}{4}$ Cwt. Sulphate of Potash.	$10\frac{1}{3}$ Cwt. Fertiliser.
NAME OF FARM.	WEIGHT OF ROOTS PER ACRE.															
	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.	T. Cwt.
Dorsencilly	7 13½	21 10½	14 13	15 10¾	21 17	23 15	24 17½	27 10¾	26 4	20 17¼	22 11¼	23 15	21 15	22 15	23 19	—
Collargreen	17 15	24 0	22 1¾	22 8	23 16½	23 8	22 7½	26 1½	24 16	22 15½	22 15¼	22 17¼	22 4¼	22 7½	22 13½	—
Dandaleith	13 16¾	21 18	22 10¾	16 5½	24 9	28 0	24 7½	30 4¼	27 19¾	22 15½	24 2¼	23 10	19 7½	21 0¼	18 7	—
Mains of Fisherie	17 18½	26 4	24 11	16 5	23 0	26 6	25 18	31 8	28 2	24 14½	22 5	26 6	24 5	25 5½	24 6	—
Kincraigie	14 8	19 2	11 4½	14 4	16 12½	17 14	16 8	19 6	17 12	14 17	18 2	18 12	15 5	17 3	16 3	—
Fasque	6 16¾	20 0	18 13¾	10 5	17 12	16 1¼	14 0	23 0	21 0	17 3¾	20 13¾	22 11¼	18 10	20 5	21 1¼	—
Mills of Rathven	11 1¼	20 2	14 6½	15 19½	22 10	21 0	19 19	21 16½	20 0½	18 0	20 2	18 18	16 8½	18 15	18 19½	—
Johnstone	14 11¾	21 5	11 3¾	18 6¼	18 0½	23 1	22 4½	25 12½	25 12	17 11½	20 15¼	20 16	20 13¾	22 1½	21 5¾	15 16¼
Greystone	0 12	22 0¼	16 16½	2 5	18 1	20 11½	16 13¾	20 9½	19 7¼	17 2¾	16 10¾	18 9	13 4½	16 5¾	16 14¼	12 19½
East Kinharrachie	2 9¾	16 7½	16 4¾	5 10½	17 12½	11 19¾	12 1¾	19 17¼	17 2½	15 17	18 17¾	18 3¼	13 3	16 12¾	16 17¾	—

Mains of Drum	8 16½	21 10½	22 0	14 11½	21 13	20 5	16 4	24 1¾	20 13	19 16¾	21 19¼	23 4½	20 5	23 1	21 7¾	—
Rettie	11 4¼	17 0	16 11½	5 0¾	16 2	19 8¼	15 10	18 16	17 1½	15 7¾	16 11	16 10¼	13 11¾	16 16	16 3½	13 17¾
Craighall	0 13	12 8	7 16½	0 11¾	11 8	7 14	6 8½	14 13	13 0	7 12¾	14 9½	13 1	1 12½	12 12	9 15	—
Insh	10 12½	23 4½	13 19½	17 19½	17 2	13 7½	12 12	25 6	20 16½	19 17¾	23 14¾	21 15½	18 18¾	26 4½	19 12½	—
Mounteagle	0 15	17 3½	11 10	1 0¾	14 3½	13 15¾	15 3½	20 11½	21 12¾	15 15	19 15¾	21 1½	14 9¼	16 10¾	16 9¼	—
Stonebriggs	8 8¼	30 8¼	27 0	15 2¾	28 3	23 19	28 17	—	—	—	—	—	—	—	—	—
*Hillhead	9 8¾	18 3¼	14 4	10 5¾	12 9½	16 2½	15 8¼	16 4¾	13 9¼	14 7¾	16 6½	15 0½	14 2	16 5	18 9½	14 3½
*Redford	5 15	14 8	5 8	0 10	15 0	—	17 12	19 16	18 14	19 18½	19 16	23 13	15 8	20 18	18 14	—
†Newton	16 3½	22 17¾	24 16½	24 7	25 1½	29 17	25 19¼	24 0¾	27 5	19 15	20 2	20 0	21 7¾	21 8¾	22 3½	—
Average	9 1	20 7½	16 3	11 4½	18 17	19 3½	18 3	22 12½	20 14½	17 18¼	19 19¾	20 9¾	16 12¾	19 14	18 17½	14 4¼
Increase over no Manure Plot	—	11 6½	7 2	2 3½	9 11	10 2½	9 2	13 11½	11 13½	8 17¼	10 18¾	11 8¾	7 11¾	10 13	9 16½	5 3¼
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Value of Increase	—	90 7	56 9	17 5	76 5	81 0	72 9	108 7	93 5	70 11	87 6	91 6	60 9	85 5	78 7	41 3
Cost of Manures	—	37 11	30 3	19 6	26 1	60 0	40 0	77 11	59 [illegible]	37 11	37 11	37 11	37 11	37 11	37 11	37 11
Profit from the use of the Manures	—	52 8	26 6	Loss 2 1	50 4	21 0	32 9	30 8	34 5	43 0	49 7	53 7	22 10	47 6	40 8	3 4

* Plots 10 to 15 inclusive received dung.

† Excluded from averages on account of high condition.

REPORT ON THE CHEMICAL AND MECHANICAL ANALYSES OF CERTAIN OF THE SOILS ON WHICH EXPERIMENTS WERE MADE.

As last year, analyses were made of a number of typical soils in which experiments were carried out. If soil analysis is to be made of any practical use to the agriculturist it can only be done by systematic mechanical and chemical analyses of the soils of each district and each geological formation, and the comparison of the results with the results obtained in manurial experiments and in practice. It is recognised that an isolated soil analysis is by itself of little use, and that for its complete interpretation some ordered knowledge of soils of the same district and the same formation and of the relations between their chemical and mechanical and their agricultural properties is necessary. Since this has come to be recognised systematic soil surveys, including mechanical and chemical analyses, have been undertaken in many places, and in some cases these have been organised and supported by Government. In a few counties in England such surveys are being undertaken by the agricultural colleges. So far as we are aware nothing has yet been done in this direction in Scotland. It is hoped that the analyses carried out in connection with our manuring experiments may help towards a better knowledge of the composition of the soils of the North of Scotland. It is believed that when the surface geology maps of this district are published it will be found that a series of analyses of typical soils of the district will be very useful when taken in conjunction with the information supplied by the maps.

The season was an excellent one for turnips, and quite unlike that of 1903 referred to in Bulletin No. 1. In 1904 the soils had every chance of showing all they were capable of doing with the turnip crop, and we have therefore a much better opportunity of comparing our agricultural with the chemical and mechanical results than in the previous season. In 1903 the effect of the bad season was so great that it was difficult to say whether deficiencies in crop were due to the chemical and mechanical imperfections of the soil or were to be ascribed to the season.

Analyses were made of eight soils. Four of these were from the county of Aberdeen, one each from the counties of Banff and Moray, and two from the county of Ross and Cromarty. Typical

soils, which had shown some marked result in the manuring experiment, were chosen for analysis. The method of taking the samples was the same as in the previous year (Bulletin No. 1, p. 19).

The following tables give the mechanical and chemical analyses of the selected soils:—

TABLE VIII.

Mechanical Analysis of Soils. Percentages of Air-Dry Material.

	Greystone.	Kinharrachie.	Johnstone.	Hillhead.	Dandaleith.	Collargreen.	Insh.
Stones over 3 mm. Diameter . .	13·46	10·10	10·59	14·07	0·68	15·85	14·00
Earth which passes 3 mm. Sieve . .	86·54	89·90	89·41	85·93	99·32	84·15	86·00

Composition of Earth which Passes 3 mm. Sieve.

	Greystone.	Kinharrachie.	Johnstone.	Hillhead.	Dandaleith.	Collargreen.	Insh.
Fine Gravel . .	9·61	5·42	8·52	13·68	0·70	3·43	3·49
Coarse Sand . .	32·30	28·87	32·56	32·63	48·15	27·69	36·56
Fine Sand . . .	25·42	23·78	21·79	19·40	29·99	23·23	33·73
Silt	10·52	9·99	11·70	13·27	8·27	13·03	10·48
Fine Silt . . .	5·95	5·28	5·73	5·29	4·10	14·53	2·61
Clay	1·45	1·58	1·49	1·87	0·85	3·33	1·16
Total of Above . .	85·25	74·92	81·79	86·14	92·06	85·24	88·03
Moisture . . .	5·92	9·66	6·60	3·18	2·04	3·29	2·76
Loss on Ignition . .	7·87	12·06	10·66	9·41	4·36	9·24	6·37
Dissolved, Including Carbonate of Lime (by Difference) .	0·96	3·36	0·95	1·27	1·54	2·23	2·84

TABLE IX.

SOILS. CHEMICAL ANALYSIS.

CONSTITUENTS.		PERCENTAGES OF DRY FINE EARTH.							
		GREYSTONE.	KIN-HARRACHIE.	JOHNSTONE.	HILLHEAD.	DANDALEITH.	COLLAR-GREEN.	INSH.	MOUNTEAGLE.
Loss on Ignition, Organic Matter, etc.		16·51	27·32	20·98	13·96	7·19	12·95	9·89	72·94
Nitrogen in same		0·367	0·488	0·233	0·283	0·177	0·290	0·219	1·654
Sand and Insoluble Silicates		77·09	70·33	66·28	77·68	89·73	77·40	88·63	18·18
Soluble in Strong Acid.	Phosphoric Acid	0·306	0·225	0·252	0·187	0·379	0·215	0·368	0·060
	Potash	0·486	0·320	0·314	0·514	0·181	0·439	0·264	0·104
	Lime	0·559	0·743	0·599	0·512	0·531	0·414	0·387	1·298
	= Carbonate of Lime	0·999	1·382	1·070	0·914	0·948	0·740	0·691	2·319
Soluble in Dilute Citric Acid. "Available."	Phosphoric Acid	0·0267	0·0286	0·0428	0·0329	0·0326	0·0424	0·0426	0·0165
	Potash	0·0161	0·0132	0·0068	0·0203	0·0114	0·0119	0·0071	0·0050
	Lime	0·165	0·169	0·192	0·153	0·184	0·260	0·135	0·460
	= Carbonate of Lime	0·295	0·302	0·343	0·273	0·328	0·465	0·241	0·821

It is now generally recognised that the mechanical nature of the soil is as important as its chemical composition. The mechanical analysis shows the percentages of mineral particles of various grades of fineness which occur in the soil. The properties and the value under cultivation of a soil largely depend on the variety and fineness of the mineral particles of which it is composed. The Agricultural Education Association has been giving much attention to this subject, and one of the present writers had the honour to be appointed by the Association to revise the official method which has been adopted in this country by the agricultural colleges in their mechanical analyses.

In connection with this work the mechanical analysis of these soils was gone into very thoroughly. The technical results of this investigation, which are of interest chiefly to specialists, will be published elsewhere. The figures given above were obtained by the method which has been officially adopted by the Association.* The following statement will give untechnical readers an idea of the sizes of the various grades of particles referred to in the analyses :—

Stones mean all mineral particles over about $\frac{1}{8}$ inch in diameter.

Fine gravel includes mineral particles under $\frac{1}{8}$ inch and over $\frac{1}{25}$ inch in diameter.

Coarse sand includes mineral particles under $\frac{1}{25}$ inch and over $\frac{1}{125}$ inch in diameter.

Fine sand includes mineral particles under $\frac{1}{125}$ inch and over $\frac{1}{625}$ inch in diameter.

Silt includes mineral particles under $\frac{1}{625}$ inch and over $\frac{1}{2500}$ inch in diameter.

Fine silt includes mineral particles under $\frac{1}{2500}$ inch and over $\frac{1}{12500}$ inch in diameter.

Clay includes mineral particles under $\frac{1}{12500}$ inch in diameter.

All the above limits of size are only approximate.

Generally speaking, the best soil from an agricultural point of view is one which contains a fair proportion of all the different grades of particles. If most of the particles are of the coarser kind, gravel and sand, the soil is too open in texture and too pervious to water to be good, while if the soil is mainly made up of silt and clay it is stiff and cold and impervious to water. Of the soils dealt with here Collargreen has the best mechanical analysis.

* *Journal of Agricultural Science*, vol. i., p. 470.

It contains particles of all grades of fineness. It has enough silt and clay to give it "substance" and "strength," while it has plenty of sand to ensure that it will be "free" and "kindly" in texture. It is a good example of a loam. Such a soil, if it has sufficient depth, and if the subsoil also is of a suitable kind, forms the most valuable kind of soil for agricultural purposes. All the other soils are "light". They contain comparatively little fine silt and clay, and will be deficient in "body" and "strength". They are all sandy loams. One, Dandaleith, might almost be called a sand. If deep, these also form valuable soils, but they are more apt to suffer from drought, and they lack the "substance" of loams such as Collargreen. A very large proportion of the soils of this district consist of loams and sandy loams. The soils analysed last year were all loams, and these, taken along with the sandy loams given above, illustrate the mechanical nature of many of the soils of the North-East of Scotland.

The chemical analysis has to be taken along with the mechanical. It shows the amounts of the constituents most important to plants which are present in the soil and to some extent tells how far they are present in a condition likely to be taken up by the roots of crops and therefore available to them. The analytical results should be studied in reference to the manurial results of Plots 1 to 5, Table VII.

With the exception of Dandaleith, all the soils are well supplied with organic matter or humus, and with nitrogen which is stored up in the humus. The turnip crop is, generally speaking, well able to supply itself with nitrogen provided there is a moderate amount of this constituent present in the soil. All the soils in the above list contain sufficient natural nitrogen for the supply of a fair turnip crop. Even the Dandaleith soil contains sufficient, as is shown by the crop of turnips obtained from Plot 5, to yield a good crop without any nitrogenous manure. The want of a larger amount of humus matter, however, will prejudicially affect the quality of this soil. As has already been pointed out above, this is the lightest of all the soils. A large supply of humus matter would help to ameliorate this lightness and diminish the tendency of this soil to suffer readily on the one hand from drought, and on the other from the washing away of its soluble constituents during wet weather. Soils such as this

are greatly benefited by dressings of all coarse organic manures. This is shown in Plots 8 and 9, where with dung it gives very large crops. This soil would probably also be benefited by green manuring. Soils such as this generally pay well for liberal treatment, especially with dung and coarse manures.

The very opposite kind of soil is Mounteagle. This soil is a peat. It contains great excess of humus matter, and would be the better if a part of this could be removed. The amount of natural nitrogen stored in this soil is enormous, but most of it is present in a state in which it is of little use to plants. This soil contained so large an amount of humus and so little mineral matter that it was not possible to make its mechanical analysis in the ordinary way.

If we except Mounteagle, none of the soils is well supplied with lime. The very peaty soil of Mounteagle has a fair supply. In such a peaty soil, however, a large supply of lime is necessary to render the soil fit for cultivation at all. All the other soils, and especially Insh, should be limed from time to time. This is typical of most of the soils of the North-East of Scotland. Generally speaking they are not naturally too well supplied with lime.

The soils from Johnstone and Insh are very badly supplied with available potash. This analytical result is fully borne out by the results of the field experiment, and is also indicated by the fact that clover will scarcely grow on the soil at Johnstone. It will be seen by reference to Table VII. that in Plot 3 the want of potash diminishes the crop on both these farms very seriously. The diminution of crop from want of potash is much more serious than that suffered from the want of any other constituent. The Mounteagle soil is also very seriously deficient in available potash. This exceptional soil, with its large supplies of organic matter, will probably be able to make better use of what natural potash it does contain than a normal soil. The soils of Collargreen and Dandaleith, though better supplied with available potash, are not rich in it, and might also be expected to respond to potash manuring.

The manurial constituent, upon an available supply of which the turnip crop most depends, is phosphoric acid. Without a large supply of readily assimilable phosphoric acid a large turnip crop cannot be grown. The results of the manuring experiment (Table VII., Plot 4) showed that three of these soils, Greystone,

Kinharrachie and Mounteagle, suffered from great deficiency in available phosphate, for without a supply of phosphate in the manure practically no crop was obtained. Judged by the rules ordinarily applied to the interpretation of soil analyses none of these soils shows great deficiency in available phosphate. The same thing was found in the soil analyses last year. Then the result was partly ascribed to the effects of the inclement season, but in 1904 that cannot have been the reason. Further investigation is required on this point, but so far as the present evidence goes the soils of this district, if they are to grow a turnip crop, require to show on analysis a much greater supply of available phosphate than has generally been found to be necessary in other districts where such investigations have been made. The investigations on which our knowledge of this subject mainly depends were made in the South of England. This is a good illustration of the necessity of carrying out systematic soil analyses on all kinds of soils and in all the different districts and climates of the country in order to enable us to interpret justly the results of analysis.

On the whole the results of the analyses indicate very soundly the requirements of the soils and are in agreement with the results of the manurial experiments. From such analyses as these, taken in conjunction with some information as to the depth of the soil and the nature of the subsoil, the manurial requirements of the soil could be gauged with a great degree of accuracy.

Mr. Davie, M.A., B.Sc., late Assistant in Agricultural Chemistry, carried out nearly all the detail work of the analyses of these soils, and we desire to acknowledge our indebtedness for his help.

Composition of Turnips.

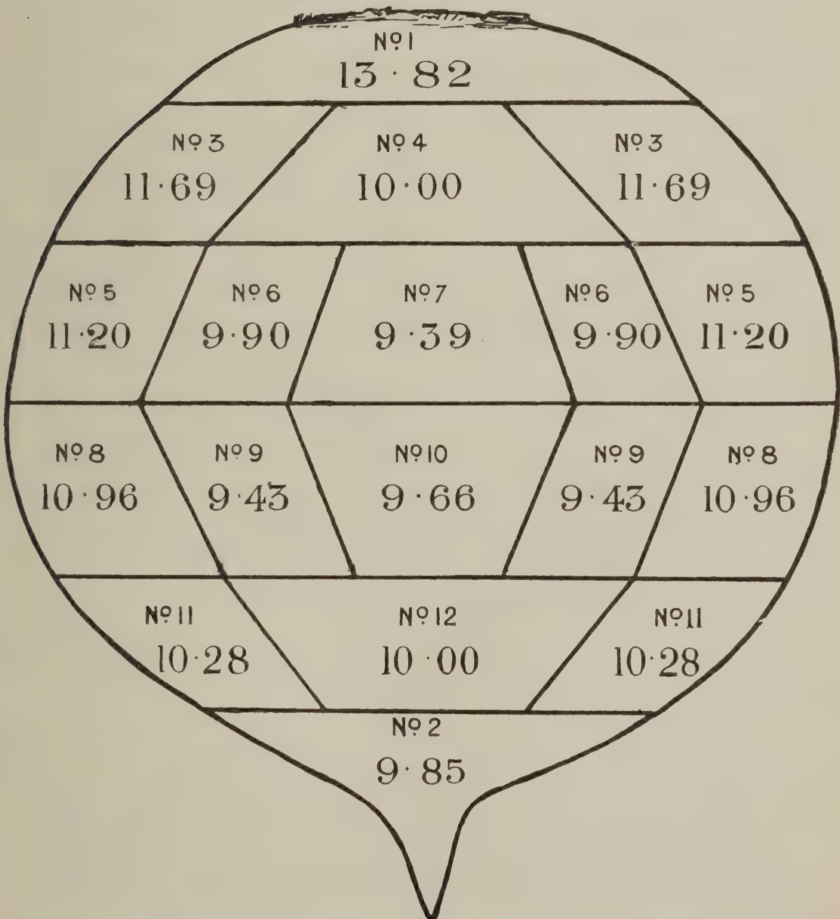
The bulb of such a plant as a turnip or swede is not uniform in composition. It appears to be a very common idea among farmers that the part of the bulb which is covered by the soil is richer than the part which projects from the soil. The variation in composition of the mangel bulb according to the part of the bulb from which the sample is taken has been studied by Mr. T. B. Wood, Cambridge University, Agricultural Department (*Journal of Agricultural Science*, vol. i., pp. 180-182). It seemed probable that similar variations would be found in the case of the swede. These variations in composition in different

parts of the bulb have also an important bearing on the method of taking samples of roots either in order to determine the composition of crops or of individual bulbs. Some determinations were, therefore, made of the variation in composition in the case of yellow turnips. The accompanying diagrams show at a glance the way in which the bulbs were cut up and the percentage of dry matter found in each part of the bulb :—

A.

GREENTOP YELLOW. WEIGHT 4 LB. $1\frac{3}{4}$ OZ.

BULB HARD AND SOUND ALL THROUGH.

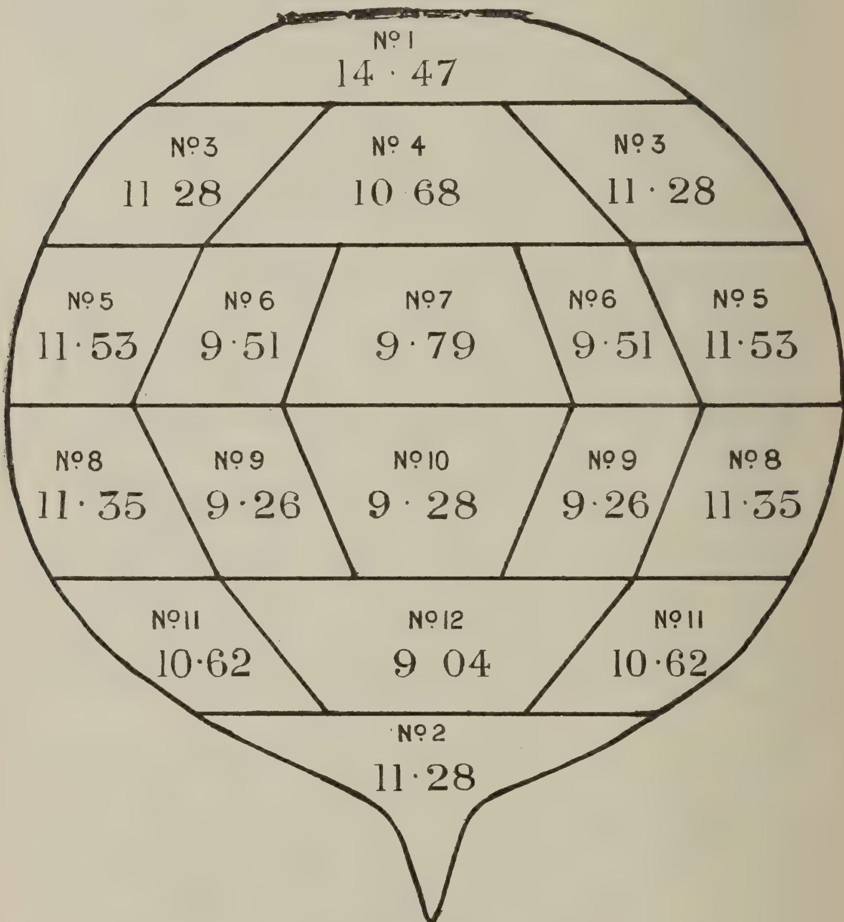


Mean = 10·51.

B.

GREENTOP YELLOW. WEIGHT 4 LB. 4 OZ.

BULB HARD AND SOUND ALL THROUGH.



Mean = 10·65.

The bulbs A and B, greentop yellows, from the same field, were each weighed and then cut into horizontal slices. The top and bottom pieces, 1 and 2, were not further divided. The other

slices were subdivided ; 3 represents a ring round the second slice and 4 the central portion of the same slice. Similarly, 5 represents the outside ring of the third slice, 6 a ring inside that, and 7 the inside portion of the slice. In this way each turnip was divided into twelve different portions from top to tail and from rind to core. Three other bulbs, representing two different varieties, were divided similarly but in a simpler manner. These gave results in general agreement with what is shown in the diagrams A and B.

In all these samples only the dry matter was determined. It is hoped that before another year more complete analyses will be made. Meantime we may summarise the results obtained as follows :—

1. The upper half of a turnip contains a higher percentage of dry matter than the lower half. This is in direct opposition to the common opinion that the under half is the richer.

2. The outside part next the rind is richer in dry matter than the inner part. As we proceed from the outside towards the centre the dry matter falls. This is true, no matter in what direction we proceed, but the difference from crown to centre is greater than the difference found in any other direction.

The above analyses show that a sample taken from a turnip by boring can only approximately represent the composition of the turnip. In order to accurately obtain its composition the whole turnip would require to be used, or at any rate a wedge passing through the centre from top to tail would require to be taken from it. This is not possible in most cases. For instance, if turnips are to be improved by the selection of seed-mothers by analysis, and the main object with which all these investigations were begun is to show that this can be done, the whole root, or even a wedge, cannot be taken. The boring method must be made use of, for a bored turnip is not spoiled, but can afterwards be made use of to grow seed. The method of boring usually adopted is to drive an auger slantingly through the centre of the bulb from a point on the shoulder just at the edge of the leaf scar to a point near the tail. This is the method of sampling which was adopted last year, and has been again adopted. A number of experiments were made in which samples were drawn in various ways, and it was found that, on the whole, samples drawn in this way

approximate to the true composition of the bulb as shown by taking wedges through the centre of the bulb from top to tail, and that they are quite as accurate as samples drawn by any of the other methods which have been proposed. In individual instances considerable differences were found, but the averages for every ten bulbs agreed closely. In any case, so long as the samples are always drawn in the same way the results will be comparable, and will enable us to select for seed-mothers the bulbs of best composition.

It is well known that individual roots of the same species grown on the same land side by side vary considerably in composition. Generally speaking, it is known that large bulbs are lower in dry matter than small ones, but both large and small bulbs vary very much among themselves. This point has already been well illustrated by Mr. T. B. Wood, Cambridge, in the case of mangels. His analysis showed very great variations among individuals, and that the connection between size and composition was only very general. In order to find how far the same thing holds for yellow turnips 100 bulbs were taken just as they grew in the drill, large and small, well shaped and badly shaped, all together. These turnips were supplied by Mr. T. H. Gibson, Culter Cullen, Foveran, and were greentop yellows from seed which had been grown and selected for many years by Mr. Gibson himself at Culter Cullen. They were held to be very sound, hard turnips of high feeding quality. The average analysis confirms this opinion. On arrival in the laboratory each turnip was cleaned and weighed, then a boring was taken in the usual manner, and the dry matter determined from it. In all ninety-seven individual bulbs were treated in this way. The following table, which records the weight and percentage of dry matter for each bulb, shows some very interesting results. The bulbs are arranged according to the percentage of dry matter which they contain. Those with the greatest percentage of dry matter come first. The average weight and the average percentage of dry matter of each ten is also recorded.

TABLE X.

Weights and Percentages of Dry Matter of Ninety-Seven Turnips of Same Variety from Same Drill.

No.	Weight of Turnips.			Percentage of Dry Matter.		No.	Weight of Turnips.			Percentage of Dry Matter.	
	Lb.	Oz.	Average of Ten.		Average of Ten.		Lb.	Oz.	Average of Ten.		Average of Ten.
1	0	10		19·8		51	1	0¾		10·6	
2	0	11¾		17·6		52	1	2¼		10·6	
3	1	12¼		15·1		53	4	1¾		10·6	
4	1	3		14·9		54	2	4½		10·5	
5	0	10	16 oz.	13·2	14·4.	55	0	8	30·75 oz.	10·5	10·5.
6	0	9		13·2		56	0	8¼		10·5	
7	1	8¾		13·0		57	0	15¼		10·5	
8	1	1		12·8		58	1	4¼		10·5	
9	1	6		12·4		59	2	4¼		10·5	
10	0	7		12·3		60	5	2¼		10·5	
11	1	0¾		12·1		61	0	8		10·4	
12	1	3		12·0		62	0	12¼		10·4	
13	1	14¼		12·0		63	1	5½		10·4	
14	1	10½		11·8		64	1	10¾		10·4	
15	1	3¾	21·4 oz.	11·8	11·7.	65	1	4½	27·1 oz.	10·3	10·3.
16	0	15¾		11·7		66	2	10¾		10·2	
17	0	13¼		11·6		67	2	13¾		10·2	
18	1	0¼		11·5		68	2	7		10·2	
19	1	7		11·4		69	2	8		10·2	
20	2	1½		11·4		70	0	14½		10·1	
21	2	14		11·4		71	2	10½		10·0	
22	1	8½		11·4		72	2	11½		10·0	
23	1	12¼		11·3		73	4	12¾		10·0	
24	0	9¾		11·3		74	1	10½		9·9	
25	0	12¼	26·25 oz.	11·3	11·3.	75	3	5¾	38·1 oz.	9·9	9·8.
26	1	2½		11·2		76	1	1½		9·8	
27	1	5		11·2		77	2	9		9·7	
28	1	8½		11·2		78	2	3¾		9·7	
29	1	12		11·2		79	1	5		9·7	
30	3	1¾		11·2		80	1	6½		9·6	
31	2	4		11·2		81	1	11¾		9·6	
32	0	12		11·1		82	0	13¼		9·6	
33	2	7¾		11·1		83	1	3		9·5	
34	3	2½		11·0		84	3	12		9·5	
35	2	6½	32·7 oz.	11·0	11·0.	85	2	4	29·3 oz.	9·5	9·4.
36	3	3		11·0		86	3	7		9·4	
37	2	8¼		11·0		87	0	9¾		9·4	
38	2	0		10·9		88	1	10¾		9·4	
39	0	9		10·9		89	1	5¼		9·3	
40	1	1½		10·9		90	1	8½		9·2	
41	1	7¾		10·9		91	2	12		9·0	
42	6	6¼		10·9		92	1	7		9·0	
43	0	11¾		10·9		93	3	9		9·0	
44	1	13½		10·9		94	3	0½		8·9	
45	2	1¼	28·7 oz.	10·8	10·8.	95	2	7½	37·7 oz.	8·8	8·8.
46	1	1¾		10·8		96	2	1½		8·8	
47	1	14½		10·8		97	1	0½		8·1	
48	0	14½		10·8							
49	—			10·7							
50	1	7½		10·7							

Average weight, 28·65 oz. Average percentage solid matter, 10·84.

On inspection of the table it will be seen that the dry matter varies from 19·8 per cent. to 8·1 per cent., but that over four-fifths of the bulbs contain dry matter, from 12 to 9 per cent. A few extraordinary individuals contain exceptionally high dry matter, while at the end of the list comes one with much lower dry matter than any of its fellows.

The turnips vary in weight from 8 oz. to 6 lb. $6\frac{1}{4}$ oz. Generally speaking, those with high dry matter are small turnips. The average weight of the first ten is only 16 oz., and their average dry matter is 14·4 per cent. The average weight for each ten continues to increase with falling dry matter till we reach 40, after that the increase is slight and very irregular. It will be seen, then, that there is no certain connection between the size of the turnip and the percentage of dry matter. In a very general way the small turnips have the high dry matter while large ones have low dry matter, but a small turnip may have low dry matter and a large one may have high dry matter. The largest turnip in the list, No. 42, comes above Nos. 55 and 61, which, with the exception of No. 10, are the smallest, in percentage of dry matter, though it is nearly thirteen times their weight. Also Nos. 39 and 42 have both 10·9 per cent. of dry matter, though one weighs only 9 oz. and the other 102 oz. Similarly, No. 55, which weighs only 8 oz., has just the same proportion of dry matter as No. 60, which weighs 82 oz. It will, therefore, be possible if only a sufficient number of turnips can be analysed, to select seed-mothers having size and shape as well as a high percentage of dry matter.

The average weight of all the turnips was $28\frac{2}{3}$ oz. and the average dry matter 10·84 per cent. This average weight may seem small, but it will be found that the average turnips grown on most land do not exceed this weight. While individual turnips may weigh many pounds the average bulb of a field does not usually weigh more than about 2 lb. If the average bulb weighs 2 lb., the drills are 27 inches wide, and there are four turnips per yard, the crop will weigh over 23 tons per acre. The average crop is not nearly so heavy as this.

The average dry matter found in these turnips is very good for yellow turnips.

Another important point on which this investigation throws light is the number of bulbs which are required to give an average

sample of a turnip crop. It is commonly supposed among practical men that six bulbs are enough to form a sufficient sample, and in many feeding and other experiments which have been done in the past, ten or twenty turnips have been considered quite sufficient to give an average sample. If we take the average of each ten bulbs of the above ninety-seven, not arranged in order of dry matter, but taken as they occur in the drill, we will find that the results do not agree ; even if we take twenties, the agreement is still very bad, and, though better with fifties, it is still by no means satisfactory. It is, therefore, necessary to take samples from a large number of bulbs if the average of a crop is wanted. In our work we endeavour to take cores from at least 100 bulbs whenever we require an average sample.

The following figures give averages of dry matter in lots of these turnips taken at random as they occur in the drill :—

First 20,	11·03 per cent. dry matter.	First 49, 10·70 per cent. dry matter.
Second 20,	10·59 ,, ,, ,,	
Third 20,	11·32 ,, ,, ,,	
Fourth 20,	10·81 ,, ,, ,,	Remaining 48, 11·06 per cent. dry matter.
Last 17,	10·60 ,, ,, ,,	

In selecting turnips by analysis for seed-mothers we require not only to select bulbs with a good percentage of dry matter, but with dry matter of good quality. A dry corky turnip may contain a high percentage of dry matter, but it would not be a desirable turnip to grow seed from. In addition to the dry matter, therefore, it will be necessary to determine whether the turnip contains dry matter of a good kind. This question might of course be answered by making a complete analysis of the dry matter of each turnip bored. In selecting turnips for seed this would be impracticable. Hundreds or thousands of bulbs have to be tested in a comparatively short space of time, and therefore any method of analysis adopted must be rapid and easy of execution. The sugar-beet has been greatly improved by selection of seed-mothers by analysis. In that case it was sugar that was wanted, and therefore methods of rapidly determining sugar were perfected to enable the selection to be carried out. These cannot be applied to the improvement of the turnip for food, first, because the sugar and other carbohydrate constituents of the turnip differ

greatly from those of the beet, and, second, because we do not wish to improve the turnip merely in sugar, but in general feeding characteristics. In most of the experiments hitherto made with a view to the improvement of the turnip the experimenters have followed the lead of those who have improved the beet, and have determined dry matter and sugar. In our last winter's work (Bulletin No. 1) we followed the same method. The experience then gained, however, led us to reject this method, and during last winter a considerable number of experiments were made in order to find a method of readily determining whether turnips were hard and juicy, or fibrous and corky inside. The density or specific gravity of the bulbs has sometimes been made use of as an indication of the quality of turnips. This, however, has been shown to be a very uncertain guide. After a number of experiments we came to the conclusion that a better guide to the quality of the dry matter is found in the amount of solid matter contained in the sap, and the ratio which this bears to the total solids. When the turnip is foggy or corky the ratio of the solids in the sap to the total solids in the turnip is low, while, when the turnip is sound and hard, the ratio between these is high. This is illustrated by the following analyses of a number of turnips selected from a field in which a great many foggy bulbs were found. All the determinations were made under the direction of one of us by Mr. David Milne, B.Sc., now of the Corporation of Western Egypt Ltd., Egypt.

TABLE XI.

	No.	Weight.		Specific Gravity.	Moisture in Bulb Per Cent.	Soluble Solids in Bulb Per Cent.	Insoluble Solids in Bulb Per Cent.	Ratio Soluble. / Insoluble.
Sound Turnips.	1	4	8¼	0·906	92·15	6·52	1·33	4·9
	4	5	1	0·913	91·44	6·13	2·43	2·5
	5	5	3	0·912	91·00	6·50	2·50	2·6
	11	3	11¼	0·968	89·70	8·01	2·29	3·5
	14	4	6½	0·953	91·33	7·48	1·19	6·3
	Average	4	9⅕	0·930	91·12	6·93	1·95	4·0
Intermediate Turnips.	3	5	5	0·820	90·70	6·46	2·84	2·3
	6	4	7	0·896	92·33	5·98	1·69	3·5
	8	4	14	0·850	91·11	7·17	1·72	4·2
	10	4	1¼	0·874	91·23	6·15	2·62	2·3
	12	3	15	0·887	90·85	6·08	3·07	1·9
	Average	4	8½	0·865	91·24	6·37	2·19	2·8
Foggy Turnips.	2	3	9	0·739	89·98	5·96	4·06	1·5
	7	3	15	0·808	90·79	6·09	3·12	1·9
	9	5	6½	0·785	91·09	5·78	3·13	1·8
	13	3	7½	0·770	90·26	6·06	3·68	1·6
	15	4	0¼	0·842	90·28	5·90	3·82	1·6
	Average	4	1¼	0·789	90·48	5·96	3·56	1·7

The density of the above turnips was first determined. They were then cut open and a wedge taken from each for analysis. They were divided into three groups of five each according to

their density and appearance. In the first group were placed all those with densities over ·9. All of these were hard and sappy, and showed no sign of fogginess. In the last division were placed those which were dry and corky inside. Most of these had densities under ·8, and the average density is under ·8. In the middle division were placed those with densities between ·8 and ·9, which were not distinctly foggy. Two of them showed signs of fogginess, and as a class they were softer than those in the first division. It will be seen that both the specific gravity and the ratio of the soluble to the insoluble solids give a good indication of the nature of the bulb. The hard, juicy turnips of the first division have high specific gravities and a high ratio of soluble solids. The corky bulbs in the last division have low gravities and a low ratio of soluble solids. The bulbs of the intermediate division fall between the others both in gravity and in ratio of soluble to insoluble solids. The above results show that this method gives promise of proving useful in enabling us to select seed-mothers not only of high percentage of dry matter, but of dry matter of good quality. We hope during the coming season to improve the method, and to devise apparatus for carrying it out rapidly on a large number of bulbs.

A large number of determinations were made in samples of yellow turnips and swedes grown on different farms during 1904, but these do not add anything important to the information which was obtained in the previous year, and which has already been dealt with in Bulletin No. 1, pp. 33-40.

We desire to record our indebtedness to Mr. W. J. Profeit, M.A., B.Sc., who assisted with much of the analytical work recorded in this Bulletin.

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 5

REPORT

ON

MANURING OF HAY

1906

BY

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LECTURER IN AGRICULTURE

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Aberdeen and North of Scotland College of Agriculture.

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MANURING OF HAY.

THE following Report deals with a manurial trial, begun in 1904 and continued in 1905, upon Hay and Pasture:—

The experiments were carried out in Aberdeenshire, at the seven stations named, by—

Mr. G. H. SMYTHE, Balcarres Arms Hotel, Echt.
Mr. D. M. GODSMAN, Mains of Fedderate, Maud.
Mr. A. MARSHALL, Townhead, Kintore.
Mr. JAMES BARRIE, Balmedie.
Mr. D. REID, Crofts, Ballater.
Mr. WM. STRACHAN, Upper Muirden, Turriff.
Mr. A. SCROGGIE, W. Kinharrachie, Ellon.

At Kinharrachie, in 1905, the crop was so light, owing to drought, that it was not weighed. Each plot (one-sixteenth of an acre), was duplicated in both years, except at one centre, and all the plots were so arranged that no duplicates were side by side.

Artificial manures only, were used and applied in spring. One-half of the Nitrate of Soda was applied later, when the grass had begun to grow.

The principle objects of the test were (*a*) to ascertain if the hay crop could be profitably dressed with artificial manures; (*b*) to discover which manurial constituent has the most effect upon the hay crop; (*c*) to compare the merits of different sources of phosphate; (*d*) to demonstrate the residual effects of the manures and the result of a second dressing.

When considering the results, the following points should be kept in mind:—

1. The grass was weighed in the field as hay, and no deductions have been made for shrinkage, so the crops shown in the table are greater than if the hay had stood some time in stack and dried out. The comparative results are not affected, however, as all the plots were weighed at the same time.

2. The hay was cut once in each year, and the foggage or aftermath is not accounted for. The profit from manuring is therefore much greater than the figures show, for in many cases the foggage on the manured plots was twice as bulky as that on the untreated ground.

3. The manures were put on in spring, and it is probable that better results would have been obtained by applying the Basic Slag, Bone Meal, and Ground Florida Phosphate in winter.

4. The effects of the manures on the quality or food value of the hay cannot be gauged from these tests.

The weights of produce stated in the following tables are deduced from nearly 300 plots, involving thousands of figures and a proportionate amount of calculation. To express the results in the clumsy and absurd fashion of stones of 22 lbs. (or to be locally exact, in stones of 21 lbs. 14 ozs.) would have greatly increased the labour of calculation, to obviate which the crops are tabulated in cwts. and decimal fractions of a cwt. per acre.

Results in 1904.

Does it pay to top-dress Hay?

Four out of seven mixtures of artificial manures have left a profit from the first cut of hay, if the crop is valued at 50/- per ton.

The loss on the other plots, with one exception is small, and disappears altogether when the foggage and second year crops are accounted for. The plot (No. 5) which incurs a considerable loss received no nitrogen, from which it appears that the practice of top-dressing rotation grasses with phosphatic and potassic manures only, is of doubtful value, if Superphosphate is the phosphatic manure and bulk of crop is the criterion.

Net Profit per Acre from the different Plots.

Plot 1	...	—	Plot 5	(loss)	12/9
" 2	...	10/7	" 6	...	2/-
" 3	...	5/2	" 7	(loss)	1/9
" 4	...	5/2	" 8	(loss)	0/3

What manurial constituent produces the most effect upon Hay?

Plot 2 received a standard dressing, consisting of Nitrogen, Phosphates and Potash, at the rate of 20 lbs., 40 lbs. and 30 lbs. per acre respectively, supplied by Nitrate of Soda, Superphosphate and Sulphate of Potash. On Plots 3, 4 and 5, one of the constituents was omitted in turn. It is quite clear, from the table below, that a complete manure produces the largest and most profitable crop, the gain being 10/7 per acre more than the cost of the manures.

The profit is, however, much understated by these figures, as the foggage was always greatly superior where the manures had

been used, and the effects of the manures on the subsequent crops are not estimated.

If the hay consists largely of rye grass, and quantity is desired, it is obvious that the manure must contain Nitrogen.

TABLE I.

SHOWING WHICH IS THE MOST ESSENTIAL CONSTITUENT.

Plot.	Approximate Quantity of Manures Applied per Acre.	Hay per Acre.	Increase due to Manures.	Cost of Manures.	Profit or (*) Loss.
		Cwts.	Cwts.	s. d.	s. d.
1.	No Manure	44·31	—	—	—
2.	1⅛ cwt. Nitrate of Soda 2 3/16 cwt. Superphosphate ½ cwt. Sulphate of Potash	58·77	14·46	25 6	10 7
3.	1⅛ cwt. Nitrate of Soda 2 3/16 cwt. Superphosphate **No Potash**	54·98	10·67	19 10	5 2
4.	1⅛ cwt. Nitrate of Soda ½ cwt. Sulphate of Potash **No Phosphate**	53.53	9·22	18 4	5 2
5.	2 3/16 cwt. Superphosphate ½ cwt. Sulphate of Potash **No Nitrogen**	44·26	·05	12 10	*12 9

What is the most useful Phosphatic Manure?

Plots 2, 6, 7 and 8 received the same quantities of Nitrogen, Phosphates and Potash, the only difference in their treatment being the source from which the Phosphate was obtained. Basic Slag and Bone Meal are much in favour as improvers of grass land; Superphosphate is less often used, but, judging by the results of our tests in 1904, Superphosphate is clearly the most profitable manure in the year of application. Basic Slag, Bone Meal and Ground Florida Phosphate give almost the same average yield, but the two latter make no profit, and Bone Meal is the most expensive and most profitless. They are supposed to be lasting manures, and Bone Meal is largely used for turnips on the ground that it does so much good to the grass two or three years afterwards. We shall see from the 1905 returns if its reputation be deserved.

TABLE II.

SHOWING WHICH IS THE MOST USEFUL PHOSPHATIC MANURE.

Plot.	Kind of Manure Applied.	Hay.	Increase due to Manure.	Cost of Manure.	Profit or (*) Loss.
		Cwts.	Cwts.	s. d.	s. d.
2.	$2\frac{3}{16}$ cwt. Superphosphate . .	58·77	14·46	25 10	10 7
6.	$2\frac{3}{4}$ cwt. Basic Slag . . .	54·76	10·45	24 0	2 1
7.	$1\frac{1}{2}$ cwt. Bone Meal . . .	54·03	9·72	26 0	*1 9
8.	2 cwt. Ground Florida Phosphate.	54·46	10·15	25 6	*0 3

Results in 1905.

Have the Manures a lasting Effect?

In 1905, the same plots are our source of information, but they are so arranged and so treated as to show what effect the manures applied in 1904 have on the grass of 1905, and what profit, if any, has resulted from a dressing in both years. The statement is frequently made that a light manure applied to hay while giving a good return in the year of application will so scourge or impoverish the land that the pasture is worse in the second year than if no artificial manure had been used. If this opinion is based on fact, the produce from plots to which manure had been applied in 1904 should be less than the crop which has received no manure. The contrary is the case.

Unmanured plots in 1905 produce . . . 36·33 cwts.
Plots manured in 1904 but not in 1905 produce 39·68 cwts.

The residue of manures applied in the previous year can thus produce over 3 cwts. of hay, but there is no plot in these experiments which received Nitrate of Soda only, and it is the application of large quantities of this fertiliser alone which is supposed to scourge the land, spoil the feeding value of the hay and deteriorate the succeeding pasture.

Table III., showing the total gains in two years and the net profit or loss, gives some interesting information on these points, but each plot must be examined individually.

TABLE III.

Showing the Effects of Manures applied in the previous Year.

Plot.	Manuring.	Hay.	Increase in 2nd Year.	Total Gain.	Profit or (*) Loss on both Years.
		Cwts.	Cwts.	Cwts.	s. d.
1.	No Manure	36·33	—	—	—
2.	Complete Manure . . .	38·68	2·35	16·81	16 9
3.	No Potash	36·99	0·66	11·33	8 5
4.	No Phosphate	41·22	4·89	14·11	16 10
5.	No Nitrogen	38·72	2·39	2·44	*6 9
6.	Complete Manure, with Slag .	40·54	4·21	14·66	12 7
7.	" " with Bone Meal	40·74	4·41	14·13	7 4
8.	" " with Ground Florida Phosphate . .	40·87	4·54	14·69	11 1

It will be remembered that Plot 2 received the standard or complete dressing, including Superphosphate, and it will be seen from Table II. that it produced the largest gain in the first year, and from Table III. the largest total gain.

In the second year, however, it appears that the quick acting Phosphate has been less effective than Slag, Bone Meal and Ground Mineral Phosphate, which confirms the general belief in the lasting properties of these manures. The initial advantage gained by the Super has, however, enabled it to give the largest net profit from the Phosphatic Manures.

Plot 3 received no Potash. In the first year, apparently this did not matter so much, as the Nitrate and Super, especially the Nitrate, gave a bulky crop of grass, but, in the second year, the Nitrate and Super having been largely used up, there is nothing to produce a crop, and thus the clovers, having been starved for want of Potash, and weakened by the overshadowing grasses in the first year, can add little to the bulk in the second.

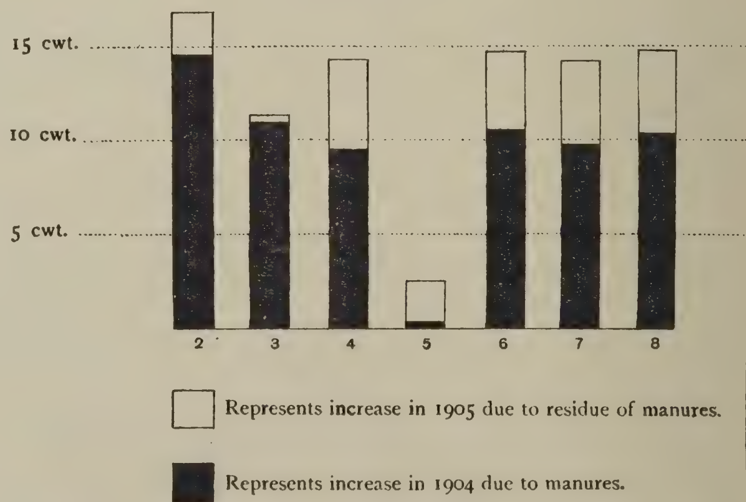
Plot 4 received no Phosphate. In the first year, the Nitrate and Potash were able to produce nearly half-a-ton of hay, the Nitrogen is, of course, used up in producing it, and nothing remains to help the second crop but the residue of Potash, but the Potash has

stimulated the clovers in the first year, and thus, by their means, we have the largest return in this plot, of any in the second year.

Plot 5 received no Nitrogen. In the first year, for want of Nitrogen, there is practically no increase of crop, but in the second year, we have more than 2 cwts. This is probably due to the clovers, but in the face of such a heavy loss on this plot, the practice of manuring with Slag and Kainit alone would appear to be far from profitable, unless the quality of the produce as a stock food is immensely improved, or unless Basic Slag gives a much better return than Super. The remaining three plots (Nos. 6, 7, and 8, along with 1) continue in the second year the comparison of the Phosphatic Manures. Here we find the slower acting sources of Phosphate doing better than Super. Whereas the residue of superphosphate gives only 2·35 cwts. of hay, what is left of the Basic Slag, Bone Meal and Ground Florida Phosphate, accounts for nearly double that quantity.

The effects of the residue are shown on Diagram A below, in which, the darkened area represents the crop of 1904, due to manuring, and the light area the returns from the residue of the manures in 1905.

DIAGRAM A.



Is it profitable to apply two successive Dressings?

Half the plots which were dressed in 1904 were re-dressed in 1905 with the same kinds and quantities of manure. This procedure is unusual in practice, but was adopted in order to obtain further information. The excessive cost of two applications makes the result doubtfully profitable. (See Table IV.)

TABLE IV.

SHOWING THE EFFECTS OF A SECOND APPLICATION OF THE SAME MANURES.

Plot.	TREATMENT.	PRODUCE IN 1905.	INCREASE IN 1905, DUE TO BOTH APPLICATIONS.	TOTAL INCREASE IN TWO YEARS.	NET PROFIT OR (*) LOSS FROM BOTH APPLICATIONS.
		Cwts.	Cwts.	Cwts.	s. d.
1.		36·33	—	—	—
2.	Except Plot 1, which remained untreated, these Plots received the same kinds and quantities of manure in 1905 as they received in 1904.	48·29	11·96	26·42	15 0
3.		45·12	8·79	19·46	8 8
4.		48·45	12·12	21·34	16 5
5.		39·97	3·64	3·69	*16 4
6.		47·87	11·54	21·99	7 0
7.		48·65	12·32	22·04	3 2
8.		47·74	11·41	21·56	2 10

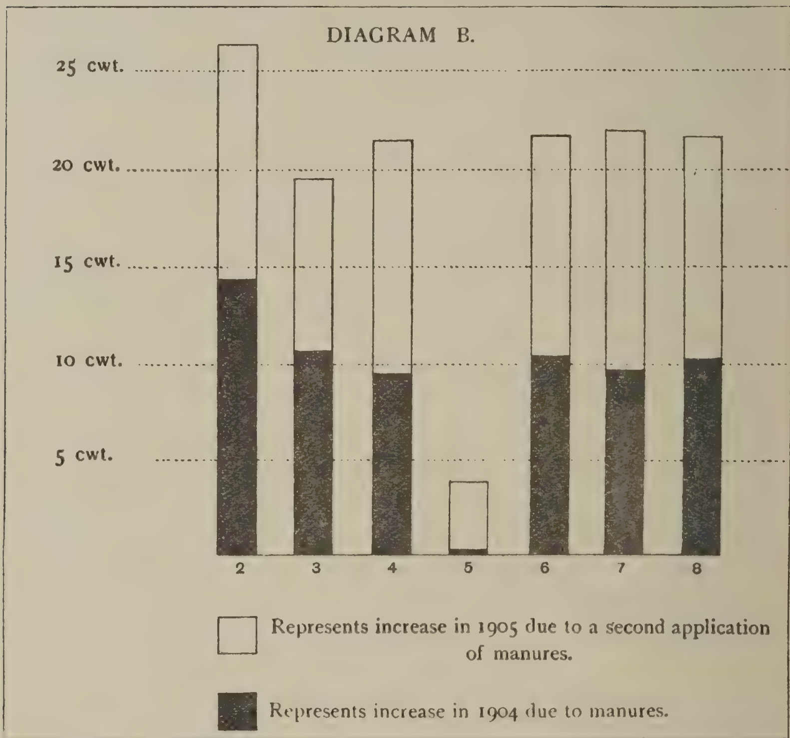
The outstanding features of the test are the increased unprofitableness of using a fertiliser which does not contain Nitrogen (Plot 5), and the effects of the second dressing of Basic Slag, Bone Meal and Ground Florida Phosphate.

These manures, when applied twice to the same land, do better than Super (compare Plots 6, 7 and 8 with Plot 2), and the small loss which they incurred when used in 1904 is turned into a small profit when they are applied again in 1905.

It is difficult to account for the apparent uselessness of Superphosphate. (See Plot 4.) This Plot, it will be noticed, received only Nitrate of Soda and Sulphate of Potash, yet it gives a larger money return than Plot 2, which was completely manured.

On the whole, the double dressing involves too large an expenditure and too small a profit to be worth risking, if we judge by averages.

The effects of the double application are clearly shown on Diagram B.



Until more experiments have been made, we may summarize the entire results as follows:—

1. A complete manure, consisting of Nitrate of Soda, Superphosphate and Sulphate of Potash, about 4 cwts. per acre, gives the largest crop and the largest profit in one application.

2. A profitable return of hay cannot be obtained if Nitrogen is omitted from the mixture.

3. Potash is more necessary than Phosphates in producing hay in Aberdeenshire.

4. Superphosphate and Basic Slag are more useful than Bone Meal and Ground Florida Phosphates in the first year of application.

5. Sulphate of Potash and all the Phosphatic Manures, but especially the slower acting, have a considerable residual value which renders them all ultimately profitable.

6. A second dressing in the following year does not produce an increase sufficiently profitable to warrant its application.

TABLE V.

SHOWING THE AVERAGE WEIGHT OF HAY OBTAINED FROM EACH SET OF DUPLICATE PLOTS IN 1904 AND 1905.

	1. No Manure.		2. Nitrate of Soda, Superphosphate, Sulphate of Potash, applied in			3. Nitrate of Soda, Superphosphate, applied in			4. Nitrate of Soda, Sulphate of Potash, applied in		
			1904.	1904 and 1905.	1904.	1904.	1904 and 1905.	1904.	1904.	1904 and 1905.	1904.
	Crop of 1904.	Crop of 1905.	Crop of 1904.	Crop of 1905.	Crop of 1905.	Crop of 1904.	Crop of 1905.	Crop of 1905.	Crop of 1904.	Crop of 1905.	Crop of 1905.
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
ECHT . . .	50·43	36·31	63·00	43·25	35·50	59·31	39·25	34·62	60·00	41·50	37·62
FEDDERATE . .	30·75	37·50	43·25	53·25	39·62	49·50	47·87	41·87	51·25	54·87	44·87
TOWNHEAD . .	56·25	43·00	73·12	60·50	43·50	66·87	57·00	43·00	60·87	59·25	54·50
BALMEDIE . .	65·00	27·50	81·50	36·50	30·50	79·25	38·75	28·62	70·68	34·87	28·50
CROFTS . . .	47·43	34·18	65·87	49·50	36·25	55·49	37·50	31·75	55·49	44·25	33·00
MUIRDEN . .	22·33	39·50	33·50	46·75	46·75	34·25	50·37	42·12	34·75	56·00	48·87
W. KINHARRACHIE	26·50	—	38·37	—	—	30·30	—	—	31·25	—	—

	5. Superphosphate, Sulphate of Potash, applied in			6. Nitrate of Soda, Slag, Sulphate of Potash, applied in			7. Nitrate of Soda, Bone Meal, Sulphate of Potash, applied in			8. Nitrate of Soda, Florida Phosphate, Sulphate of Potash, applied in		
	1904.	1904 and 1905.	1904.	1904.	1904 and 1905.	1904.	1904.	1904 and 1905.	1904.	1904.	1904 and 1905.	1904.
	Crop of 1904.	Crop of 1905.	Crop of 1905.	Crop of 1904.	Crop of 1905.	Crop of 1905.	Crop of 1904.	Crop of 1905.	Crop of 1905.	Crop of 1904.	Crop of 1905.	Crop of 1905.
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
ECHT . . .	52·62	39·25	41·75	56·62	—	42·50	59·37	—	41·75	58·37	—	41·50
FEDDERATE . .	31·25	38·50	35·87	43·00	54·75	47·00	46·14	55·25	44·75	46·25	57·87	46·87
TOWNHEAD . .	54·37	52·25	44·00	71·25	53·37	40·37	65·00	53·00	42·50	66·25	46·50	42·00
BALMEDIE . .	60·62	27·37	29·50	73·75	36·62	27·12	72·61	36·75	26·62	73·81	36·87	26·87
CROFTS . . .	50·18	39·25	37·00	57·68	46·37	40·25	38·56	46·50	42·12	57·37	44·25	39·50
MUIRDEN . .	25·25	43·25	44·25	36·25	48·25	46·00	31·25	51·75	46·75	32·50	53·25	48·50
W. KINHARRACHIE	25·25	—	—	35·50	—	—	33·12	—	—	35·12	—	—

Hay Experiments at Fasque, Fettercairn.

Through the courtesy of Sir John R. Gladstone, Bart. of Fasque, and by arrangement with Mr. A. Dewar, Fasque Estates Office, several experiments on the manuring of hay on a large scale were begun at Fasque in 1905, at the expense of the proprietor.

Each plot being ½ an acre in extent gives the test a greater interest to those who may imagine the larger areas are better guides to manurial effects.

The trials are simple in design, and intended mainly to throw some light on the profitable use of Slag and Kainit on the Fasque Estates.

The manures were generally applied in early spring, except the Nitrate of Soda, which was put on in May when the grass had begun to grow. One trial was made on clover hay and one on meadow hay at Fasque, and a comparison of Slag and Kainit was made at Thainston by Mr. Dewar. The clover hay trial to demonstrate the most essential manure provides confirmation of some of the results obtained from the experiments already described. We find, as before, that when Nitrogen is omitted from the mixture, the crop is reduced far below the limits of profit.

	Weight of Hay. Tons	Cwts.
4 cwts. Super, 4 cwts. Kainit, ½ cwt. Nitrate of Soda	1	17
4 cwts. Super, 4 cwts. Kainit, no Nitrate of Soda .	1	10
No Manure	1	6

The want of Nitrogen reduces the crop by 7 cwts. per acre.

When Slag is used instead of Superphosphate, the former gives a slightly better crop.

	Weight of Hay. Tons	Cwts.
5 cwts. Slag, 4 cwts. Kainit, ½ cwt. Nitrate .	1	19
4 cwts. Super, 4 cwts. Kainit, ½ cwt. Nitrate	1	17

The Super and Slag contained the same qualities of Phosphoric Acid.

When a heavy dressing of Super is used with Nitrate of Soda it produces practically the same effect as a heavy dressing of Kainit.

	Weight of Hay. Tons	Cwts.
8 cwts. Super, ½ cwt. Nitrate of Soda	2	1
8 cwts. Kainit, ½ cwt. Nitrate of Soda	2	0

At Thainston, Super and Slag are again compared, and again to the detriment of Super, but here the Super and Kainit were sown nearly nine weeks after the Slag and Kainit, so their inferior effect is less surprising.

	Weight of Hay. Tons	Cwts.
No Manure	1	3
Slag	1	4
Super	1	2

It is evident that Super and Slag have no effect on this soil. When Kainit is added to each, however, we get a better return.

	Weight of Hay. Tons	Cwts.
No Manure . . .	1	3
Slag and Kainit . . .	1	8
Super and Kainit . .	1	7

But still, the gains are far too small to pay for the manures.

Meadow Hay.

On Meadow Hay, Slag and Kainit nearly double the produce, but again Kainit is the more effective ingredient.

	Weight of Hay. Tons	Cwts.
No Manure . . .	0	12
8 cwts. Slag . . .	0	15
5 cwts. Slag, 4 cwts. Kainit.	1	2

These results are not in accordance with the general belief in the efficacy of Slag, or Slag and Kainit as a dressing for grass. It is true that some of the crops, of Meadow Hay, for instance, are sufficiently augmented to pay for the manure by the first cut, and, that being so, all the future increase, which we may reasonably believe to be considerable, will be clear profit. It is also true, that as the Slag was applied in Spring, it may have been too late to affect the crop of 1905, but, on the other hand, we find at other centres, that, on a soil to which it is suited, Slag will produce an extraordinary result within six months of its application. Superphosphate is even less profitable than Slag; in fact, the only feature of the Fasque experiments encouraging to the user of artificial manures for grass is the effect of Kainit. This cheap fertiliser has made its mark at each of the three places, and its effect is, of course, by no means over in the first year.

Aberdeen and North of Scotland
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REPORT

ON

OAT TRIALS

1904

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OAT EXPERIMENTS, 1904.

THE oat variety trials which were begun in Morayshire and Ross and Cromarty in 1903 were continued in these counties and in Aberdeenshire in 1904.

The object of the trials is to discover the comparative merits of some of the recently introduced varieties of oats.

Experience in other districts has shown that the native oats of Scotland are inferior as grain producers to some, if not all, of the kinds which have been introduced from America and Germany or produced by crossing with foreign strains. As the oat is by far the most important cereal of the North of Scotland, and Aberdeen the largest oat-growing county, it is of the first importance to ascertain if the local varieties are giving the largest possible returns per acre.

In the trials of 1903 the superiority of American varieties such as Banner and Siberian was marked in the good climate of Morayshire, while even in the later climate of Ross-shire and in an exceptionally cold wet season the "new" varieties gave a good account of themselves. It is too early to place the oats which have been tested in a definite list according to their merits; they must run the gauntlet of more seasons, good and bad, and more soils late and early, before the older strains can be safely discarded in favour of the new, but from the knowledge already gained it is permissible to infer that the loss by the use of the old kinds like Potato and Sandy is, in some cases, equal to the rent of the farm, and in a few cases equal to twice that amount.

To displace the popular kinds at present widely grown, a new variety must in the first place produce a greater money value of produce per acre. If the increased produce is in sufficient excess, slightly inferior quality of grain and straw will not matter, but if in addition to bulk, grain good for milling and straw good for

feeding can be obtained, then the intruders will come to stay. Judging by previous analysis the grain and straw of the new varieties are on the whole slightly inferior to the old, but unless the difference in composition is accompanied by a much greater difference in feeding value, the inferiority of such oats as Banner and Siberian is negligible. The question of feeding quality can only be settled by many feeding experiments, and those we have not yet attempted. In milling power we have reason to believe that the new are quite equal to the old, but on that point more information is required.

The experiments of 1904 are designed as a further contribution to our knowledge of—

(1) The grain and straw production,

(2) The milling power,

(3) The composition

of some of the most promising of recently introduced varieties. The experiments were carried out on plots one-quarter of an acre in extent. The land was carefully measured, and in nearly all cases the seed was sown under the supervision of a representative of the College. The plots were inspected during growth, and notes made of any peculiarities of soil or season which were likely to affect the results.

The Seed.

To make these experiments as accurate as may be, all the seed should be grown on one farm or in one district in the previous year.

At present this is impossible, and in regarding the results it should be kept in mind that a change of seed may have gone far to produce a temporary superiority. The effect of change of seed is being tested in the 1905 experiments.

Potato, Newmarket, Waverley and Banner came from the Glasgow district, Wide Awake from Ayrshire, and Siberian and Thousand Dollar from Cambridgeshire, while Scots Birlie was obtained in Aberdeenshire.

All the seed of the Morayshire experiments, except Colossal, had been grown in Morayshire the previous year. Colossal was obtained directly from Messrs. Garton Bros.

As in previous experiments the seed was sown at the rate of 3,000,000 grains per acre.

TABLE I.

Showing the Varieties of Oats Tested, the Weight of 500 Grains in Grams, the Number of Lb. per Quarter Acre at the Rate of 3,000,000 Grains per Acre, and the Approximate Number of Bushels which were Sown per Acre.

ABERDEENSHIRE.

Variety.	Weight of 500 Grains.	Lb. per Quarter Acre.	Bushels (Approximate) per Acre.
	Grams.		
Potato	16·38	63	6
Newmarket . . .	23·75	91	$8\frac{2}{3}$
Wide Awake . . .	19·10	$73\frac{1}{2}$	7
Waverley . . .	19·77	76	$7\frac{1}{4}$
Siberian	21·25	$81\frac{3}{4}$	$7\frac{3}{4}$
Thousand Dollar . .	20·12	$77\frac{3}{4}$	$7\frac{3}{7}$
Banner	17·80	$68\frac{1}{2}$	$6\frac{1}{2}$
Scots Birlie . . .	15·18	$58\frac{1}{2}$	$5\frac{1}{2}$
MORAYSHIRE.			
Potato	16·38	63	6
Colossal	24·67	95	9
Wide Awake . . .	19·10	$73\frac{1}{2}$	7
Newmarket . . .	20·35	$78\frac{1}{4}$	$7\frac{2}{3}$
Thousand Dollar . .	22·40	86	$8\frac{1}{4}$
Goldfinder . . .	20·82	80	$7\frac{3}{4}$
Siberian	21·25	$81\frac{3}{4}$	$7\frac{3}{4}$
Banner	22·26	86	$8\frac{1}{4}$

In Morayshire Scots Birlie and Waverley were replaced by Goldfinder and Colossal.

On Table II. will be found the details regarding the farms and the occupiers, along with the varieties which were first, second and third as grain producers.

TABLE II.

Table showing the Varieties which were First, Second and Third as Grain Producers at each place.

Farm.	Occupier.	First.	Second.	Third.
Echt	Mr. G. H. Smythe	Banner	Waverley	Siberian
Tipperty	Mr. Wm. Gordon	Siberian	Banner	Thousand Dollar
Denwell	Mr. John Craib	Siberian	Newmarket	Waverley
Fintry	Mr. J. K. Ledingham	Newmarket	Thousand Dollar	Banner
Mains of Cairnbulg	Mr. John Esslemont	Siberian	Thousand Dollar	Waverley
Tavelty	Mr. Alex. Lindsay	Thousand Dollar	Banner	Scots Birlie / Siberian
Corsiestone	Mr. Wm. Scott	Banner	Newmarket	Wide Awake
Auchreddie	Mr. Geo. Fowlie	Banner	Wide Awake	Thousand Dollar
Tulloch	Mr. L. Strachan	Newmarket	Thousand Dollar	Potato
Harestone	Mr. J. W. Findlay	Thousand Dollar	Banner	Newmarket
Surradale	Mr. G. A. Ferguson	Banner	Wide Awake	Siberian
Myreside	Mr. Alex. Russell	Siberian	Thousand Dollar	Banner
Linksfield	Colonel Johnston	Newmarket	Goldfinder	Siberian
Rosehaugh	J. D. Fletcher, Esq.	Wide Awake	Goldfinder	Banner
Invergordon Castle	Capt. MacLeod of Cadboll	Newmarket	Siberian	Waverley

Grain Production.

The table above is worth a cursory examination. As there are fifteen centres it is possible for one variety to be in the honours list only fifteen times. We can, therefore, get a rough estimate of the position of each kind by counting the number of times it appears on the list. Banner is mentioned ten times—four times first, three times second and three times third. Siberian and Thousand Dollar are each mentioned eight times, Newmarket seven times, etc. The others occur so seldom that they are easily outclassed. It is noteworthy that Potato and Scots Birlie are mentioned only once, and then in the third place.

Which is the Best Grain Grower—on the Average?

We have seen that Banner obtains the lion's share of honours, and consideration of Table III. shows that it has given the largest

TABLE III.

Showing the Average Yield of Dressed Grain in Centals per Acre from each Variety in Order of Merit, the Increase over the Worst Grain Producer and the Assumed Value of the Increase.

ABERDEENSHIRE.

Variety.	* Centals per Acre.	Increase over Potato.	† Assumed Value of Increase.
Banner	29·81	5·65	26/11
Thousand Dollar	29·24	5·08	24/2
Newmarket	29·03 ?	4·87	23/2
Siberian	28·12	3·96	18/10
Wide Awake	27·21	3·05	14/3
Waverley	26·73	2·57	12/3
Scots Birlie	25·14	·98	4/7
Potato	24·16	—	—
MORAYSHIRE.			
Siberian	32·32	5·63	26/10
Banner	32·26	5·57	26/6
Newmarket	31·44	4·75	22/7
Wide Awake	30·39	3·70	17/7
Thousand Dollar	28·78	2·09	10/-
Goldfinder	27·72	1·03	5/-
Colossal	27·43	·74	3/6
Potato	26·69	—	—

* A cental = 100 lb., or 2½ bushels of 40 lb., and is more convenient and more accurate for comparison than a bushel, which may contain any weight from 35 to 48 lb.

† 16s. per 336 lb.

average yield in Aberdeenshire, and the second best yield in Morayshire. In the latter county Banner would certainly have proved the best but for the fact that at Myreside it occupied the end of the row of experimental plots where the land suddenly became shallow near an outcrop of rock. Potato, as usual, is at the bottom of the list. The horizontal line divides the crops above the average from those below the average, and it will be seen that the same four varieties are above the line in each county, while Thousand Dollar does better in Aberdeenshire than in Morayshire.

Which are the Best Grain Growers at each Farm?

The best three grain growers on each farm have already been shown on Table II. The actual quantity of dressed grain produced, and the varieties which yield more than the average of the farm, are shown on Table IV. To understand the table, take the first farm Echt as an example. The average production of all the plots is seen in the last column to be 27 centals 70 lb. per acre, or 2,770 lb. Banner, Thousand Dollar, Siberian, Waverley and Scots Birlie in bold type are above the average, the remainder below.

A mere glance at the table shows how much oftener the new varieties are above than below the average.

Which are the Best Average Straw Producers?

In former trials the old varieties were shown to be better straw producers than the new, and this characteristic is confirmed in 1904.

But while Potato and Scots Birlie retain their position as straw growers, we find again, as in Morayshire in 1903, that Banner and Siberian are not by any means at the bottom of the list. Comparing Banner with Potato in both counties, it is seen that in Aberdeenshire Banner produces 1 cwt. less straw and 5 cwt. more grain, and in Morayshire 5 cwt. less straw and 5 cwt. more grain.

It is frequently asserted as an objection to the grain-growing varieties that the extra yield of grain is counterbalanced by the deficiency of straw.

The grain growers in 1904 in Aberdeenshire produced exactly

TABLE IV.

SHOWING THE QUANTITY OF DRESSED GRAIN ON EACH FARM. THE VARIETIES WHICH ARE ABOVE THE AVERAGE YIELD BEING IN HEAVY FIGURES.

ABERDEENSHIRE.

	Banner.	Thousand Dollar.	New-market.	Siberian.	Wide Awake.	Waver-ley.	Scots Birlie.	Potato.	Average,
Echt	**35·00**	**28·42**	25·50	**29·28**	24·00	**30·40**	**28·52**	20·56	**27·70**
Tipperty	**30·92**	**30·44**	**28·80**	**31·16**	26·80	26·44	27·36	26·04	**28·48**
Denwell	**33·30**	31·34	**33·78**	**34·20**	**33·14**	**33·44**	30·62	26·60	**32·05**
Fintry	**34·40**	**35·94**	**37·05**	**33·24**	**33·17**	32·60	26·40	30·72	**33·03**
Cairnbulg	28·08	**31·44**	**28·92**	**33·16**	28·44	**28·96**	*11·72	21·00	**28·57**
Tavelty	**26·96**	**29·42**	*20·16	**26·88**	22·72	22·84	**26·88**	24·64	25·76
Corsiestone	**35·36**	**32·00**	**33·80**	**32·16**	**32·60**	30·36	28·00	26·40	**31·33**
Auchreddie	**25·84**	**22·36**	21·16	19·80	**23·80**	20·16	19·24	18·88	21·40
Tulloch	**20·40**	**22·88**	**24·92**	15·30	**21·24**	17·64	14·76	**22·10**	19·90
Harestone	**27·92**	**28·16**	**27·32**	26·08	**26·20**	24·52	24·48	24·68	26·17
Average	**29·81**	**29·24**	**29·03**	**28·12**	27·21	26·73	25·14	24·16	27·43

MORAYSHIRE.

	Siberian.	Banner.	New-market.	Wide Awake	Thousand Dollar.	Gold-finder.	Colossal.	Potato.	Average.
Surradale	**35·00**	**38·92**	**34·20**	**37·04**	31·84	26·52	33·04	**34·04**	**33·82**
Linksfield	**30·98**	**30·28**	**32·86**	26·70	26·80	**32·70**	22·70	25·08	28·51
Myreside	**31·00**	**27·60**	**27·26**	**27·44**	**27·72**	23·96	**26·60**	20·96	26·57
Average	**32·32**	**32·26**	**31·44**	**30·39**	28·78	27·72	27·43	26·69	29·63

* Damaged by birds.

TABLE V.

Showing the Total Quantity of Straw and Chaff Grown on Each Farm. The Varieties which are Above the Average Yield Being in Heavy Type.

ABERDEENSHIRE.

	Scots Birlie.		**Potato.**		**Banner.**		Waverley.		Siberian.		Thousand Dollar.		New Market.		Wide Awake.		Average.	
	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.
Echt	**36**	**40**	24	30	**29**	**82**	**27**	**96**	22	87	25	26	18	75	19	102	25	67
Tipperty . . .	**42**	**56**	29	68	**31**	**48**	27	0	**31**	**80**	27	44	24	64	26	88	**30**	**14**
Denwell . . .	**26**	**88**	**23**	**80**	22	68	**24**	**28**	22	36	20	76	22	0	**27**	**16**	23	77
Fintry . . .	**35**	**82**	29	84	29	34	29	28	27	33	**30**	**95**	**32**	**28**	26	75	**30**	**15**
Cairnbulg . . .	**38**	**36**	27	108	28	14	**29**	**12**	**31**	**0**	25	50	26	40	25	80	**29**	**0**
Tavelty . . .	**36**	**35**	**39**	**84**	**33**	**24**	30	56	31	39	30	35	25	56	27	28	**31**	**87**
Corsiestone . .	21	12	**25**	**0**	23	68	22	48	23	32	22	28	**24**	**64**	**25**	**100**	23	72
Auchreddie . .	**25**	**16**	**25**	**88**	**24**	**84**	24	0	23	84	**25**	**4**	23	76	**24**	**108**	24	72
Tulloch . . .	14	62	**28**	**28**	**23**	**0**	**24**	**56**	**24**	**56**	20	0	**24**	**28**	20	16	22	45
Harestone . . .	**20**	**28**	**19**	**64**	18	100	18	12	18	60	**20**	**44**	**20**	**100**	18	20	19	40
Average . . .	29	79	27	41	26	52	25	78	25	73	24	85	24	30	24	29	26	3

MORAYSHIRE.

	Potato.		**Goldfinder.**		**Colossal.**		**Siberian.**		Banner.		Wide Awake.		New Market.		Thousand Dollar.		Average.	
	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.	Cwt.	Lb.
Surradale . . .	**44**	**0**	33	84	**39**	**24**	31	56	33	80	**36**	**104**	29	16	28	72	**34**	**68**
Linksfield . . .	**31**	**69**	27	94	25	66	**29**	**54**	**29**	**50**	23	104	**31**	**42**	27	92	28	43
Myreside . . .	27	108	**31**	**100**	**28**	**68**	**31**	**96**	24	48	26	34	24	102	**28**	**32**	28	3
Average . . .	34	59	31	18	31	14	30	106	29	22	29	6	28	53	28	28	30	38

1 qr. more grain than the straw producers, while the straw producers yielded 3 cwt. more straw.

Assuming that 40 acres of Banner Oats and 40 acres of Potato Oats on the same farm are available for sale, we have in the case of the Banner 40 extra quarters of grain worth £32. In the case of the Potato 120 cwt. of straw. It is clear that 6 tons of straw fed to cattle will not produce £32 worth of increase, nor if made into dung and returned to the land will 6 tons be worth £32 as manure. To compare them from another point of view, the grain growers produced 336 lb. more grain, worth $2\frac{2}{7}$ of a penny per lb. Straw growers produced 336 lb. more straw, worth $\frac{2}{7}$ of a penny per lb.

It must be kept in mind, however, that the season of 1904 was on the whole favourable to the new kinds of oats; in a wet year the 3 cwt. of straw might be increased to 13.

It must also be remembered that the above calculation is derived from averages, and the results from each farm should be studied by those in the neighbourhood of the farm. A general view of the relative value of the different kinds will be obtained from Table VI.

TABLE VI.

Relative Money Value of Each Variety on Each Farm. The Varieties which are Above the Average Yield Being in Heavy Type.

ABERDEENSHIRE.

	Banner.	Thousand Dollar.	New-market.	Siberian.	Waverley.	Wide Awake.	Scots Birlie.	Potato.	Average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Echt	11 8 11	9 7 7	8 0 3	9 8 8	10 3 1	7 15 10	10 14 7	7 12 9	9 6 5
Tipperty	10 14 7	10 4 8	9 10 11	10 16 4	9 4 9	9 6 6	11 2 3	9 9 0	10 1 1
Denwell	10 7 8	9 13 5	10 8 0	10 11 11	10 12 4	10 16 11	10 6 9	9 1 1	10 4 9
Fintry	11 5 0	11 14 4	12 2 8	10 15 7	10 16 9	10 13 2	9 19 0	10 7 11	10 19 4
Cairnbulg	9 12 2	10 1 11	9 12 4	11 3 8	9 18 11	9 9 3	—	8 4 8	9 14 8
Tavelty	10 5 4	10 2 4	—	9 17 2	8 16 5	8 18 11	10 3 10	9 18 10	9 14 8
Corsiestone	10 18 1	9 18 10	10 11 10	10 1 3	9 12 11	10 9 8	8 17 6	8 18 5	9 18 7
Auchreddie	8 15 1	7 19 10	7 11 0	7 4 3	7 7 7	8 5 6	7 5 5	7 3 8	7 14 1
Tulloch	7 9 1	7 13 2	8 11 1	6 8 7	6 19 11	7 8 1	5 0 10	8 8 6	7 4 11
Harestone	8 12 9	8 16 9	8 14 4	8 3 1	7 15 2	8 3 2	7 19 0	7 18 1	8 2 9
Average	9 18 10	9 11 3	9 9 2	9 9 1	9 2 9	9 2 8	9 1 0	8 14 3	9 6 1

Grain 16s. per qr., and Straw 40s. per ton.

MORAYSHIRE.

	Siberian.	Banner.	New-market.	Wide Awake.	Gold-finder.	Potato.	Thousand Dollar.	Colossal.	Average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Surradale	12 19 4	14 2 8	12 7 7	13 18 11	11 1 9	13 19 11	11 13 0	13 1 7	12 18 1
Linksfield	11 7 2	11 4 2	12 4 1	9 14 1	11 16 1	10 0 2	10 2 4	8 15 9	10 12 11
Myreside	11 13 5	9 18 2	9 17 9	10 2 9	10 11 3	8 11 8	10 7 8	10 4 1	10 3 4
Average	11 19 11	11 15 0	11 9 10	11 5 3	11 3 0	10 17 3	10 14 4	10 13 10	11 4 9

Grain 18s. per qr., and Straw 40s. per ton.

Time Required to Mature.

In a late district earliness is a valuable property, and a strain which is otherwise a good cropper may be useless in a backward season. The table below shows the time required by each of the different kinds to reach full ripeness.

TABLE VII.

Time Taken to Mature.

Number of Days Under or Over the Average.

ABERDEENSHIRE. Average 151½ days.			MORAYSHIRE. Average 135 days.		
Newmarket .	under average	4½ days.	Banner . .	under average	3½ days.
Scots Birlie .	,,	4 ,,	Newmarket .	,,	2½ ,,
Potato . .	,,	3 ,,	Potato . .	,,	2½ ,,
Banner . .		—	Thousand Dollar	,,	2½ ,,
Thousand Dollar,	over average	½ day.	Siberian .	,,	2 ,,
Siberian . .	,,	1½ days.	Colossal . .	,,	—
Waverley . .	,,	1½ ,,	Wide Awake .	over average	4½ days.
Wide Awake .	,,	7½ ,,	Goldfinder .	,,	8½ ,,

It is evident that Wide Awake in Aberdeenshire and Wide Awake and Goldfinder in Morayshire are the only kinds to which exception may be taken.

The Milling Properties.

In 1903 a number of tests of the milling powers of the various oats under trial was made. The results were not satisfactory, but tended on the whole to show that Potato and Hamilton were not such good meal producers as Sandy and Newmarket. In 1904 a similar milling test at five places was undertaken. Four bushels (168 lb.) of each variety were tested with the utmost care, the loss of weight on drying determined, and the weight of husks, dust and "sids" taken. The data obtained are of great interest,

and show among other results a smaller proportion of husks when the oats are grown on clay, and a general but not invariable relationship between the proportion of husk and the produce of meal.

The outstanding feature of the experiment, however, is the comparatively poor result from Potato and Scots Birlie, comparatively poor in the sense that the reputation of these oats as millers is not justified by the figures.

The average produce from 168 lb. of oats is 100 lb. of meal, and the local kinds are capable of producing as much but apparently not more, whereas general opinion would credit them with a larger out-turn.

Table VIII. shows the meal from each of the five centres and the average from all, and there is nothing to indicate the superiority of Potato or Scots Birlie.

TABLE VIII.

MILLING TEST.

MEAL OBTAINED FROM 168 LB. GRAIN.

	ECHT.	DENWELL.	CAIRNBULG.	TIPPERTY.	HARESTONE.	AVERAGE.	
	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Per Cent.
Siberian	101	101	103½	104½	101	102·2	60·7
Thousand Dollar	100	100	100	105½	101	101·3	60·3
Waverley	101	101	99	103	102	101·2	60·2
Scots Birlie	98	104½	100½	105	96	100·8	60·0
Wide Awake	96	104	103	98	103	100·8	60·0
Newmarket	101	100	101	100	101	100·6	59·8
Banner	100½	101	99½	98	103	100·4	59·7
Potato	95	104	102	105	95	100·2	59·6

In fact it would appear that if the soil affects the meal-producing power, these two latter oats are not trustworthy millers, as

they vary between one farm and another more than their competitors. Potato, for example, varies from 95 lb. at Echt to 105 lb. at Tipperty, or 10 lb. in all. Scots Birlie from 96 lb. at Harestone to 105 lb. at Tipperty, or 9 lb.; while Newmarket shows practically no variation, and the others only 3 or 4 lb. It is worth noting that the difference of 10 lb. between Echt and Tipperty means 140 lb. of meal in a 7-quarter crop, or 12s. to 14s. per acre.

The total quantity of meal produced per acre is of course much greater from such oats as Banner and Siberian, as the following figures show:—

Banner	1,779 lb. meal per acre.
Thousand Dollar . .	1,763 ,, ,,
Newmarket . . .	1,736 ,, ,,
Siberian	1,706 ,, ,,
Wide Awake . . .	1,632 ,, ,,
Waverley	1,609 ,, ,,
Scots Birlie . . .	1,508 ,, ,,
Potato	1,440 ,, ,,

Oat Trials in Ross and Cromarty.

Through the kindness of Captain McLeod, of Cadboll, and Mr. J. Douglas Fletcher, of Rosehaugh, an extensive trial of oat varieties was made at Invergordon Mains and Avoch.

The plots were one-twentieth of an acre, and nineteen varieties were tried at Invergordon and twenty at Avoch. At the latter centre two mixtures were also tried, *viz.*, Storm King and Tartar King and Hamilton and Potato, but in neither case has the mixing proved decidedly advantageous.

Table IX. gives the results per acre and requires almost no comment. The low place occupied by Sandy, Hamilton and Scots Birlie in both tests confirms the results of the trials farther south, while Banner, Siberian and Newmarket in the drier and sunnier year of 1904 give a better account of themselves than in 1903.

No returns of straw were obtained from Rosehaugh.

TABLE IX.

Showing Produce of One-Twentieth Acre Plots at Rosehaugh and Invergordon Mains.

Variety.	Rosehaugh.			Invergordon Mains.		
	Ripe Sept.	Total Grain per Acre. Centals.	Dressed Grain per Acre. Centals.	Ripe Aug.	Dressed Grain per Acre. Centals.	Straw and Chaff per Acre. Cwt.
Wide Awake .	16	42·80	39·80	31	16·00	30¼
Newmarket .	17	41·20	38·40	24	19·90	27
Goldfinder . .	9	41·20	36·80	29	16·00	33½
Banner . .	9	37·20	35·20	27	16·50	24¼
Siberian . .	9	39·40	35·00	27	18·40	30½
Stable King .	9	41·60	35·00	27	13·80	26½
Scottish Chieftain	8	35·00	32·80	27	15·50	24¼
Storm King . .	1	35·60	32·40	20	14·40	29½
Waverley . .	10	37·00	32·40	27	16·80	29½
Thousand Dollar .	8	33·60	31·60	29	16·20	24½
Triumph . .	6	33·80	31·40	20	12·50	27¾
White Cluster .	8	35·80	29·40	27	14·60	40
Excelsior . .	6	30·80	28·00	20	11·20	27¾
Tartar King .	5	31·80	27·20	20	6·80	30¼
Colossal . .	8	30·20	26·60	27	12·80	28¼
Hamilton . .	8	31·60	25·80	27	12·20	29
Scots Birlie .	8	33·00	24·20	27	11·10	18¼
Potato . . .	8	27·00	21·00	24	15·70	32
Sandy . . .	8	28·80	17·80	27	13·80	42¾
Early Angus .	8	33·80	23·20			
Storm King and Tartar King .	5	32·40	26·80			
Hamilton and Potato . . .	8	32·20	24·80			

Summary.

That as grain producers in good years Banner, Thousand Dollar, Newmarket and Siberian are undoubtedly superior to the varieties commonly grown in the North of Scotland.

That the older local varieties, on the other hand, produce more straw as a general rule.

That the excess of grain is more than equal to the deficiency of straw in the new strains.

That there is nothing to justify the assumption that Potato is a better milling oat than the more prolific kinds.

We have to thank Mr. W. M. Findlay, N.D.A., and Mr. T. H. Gibson, for assistance in compiling the tables and supervising the trials.

COMPOSITION OF OATS.

In continuation of work carried on in previous years, the composition of the grain and straw of a number of the varieties of oats grown in Morayshire and Aberdeenshire were determined. In the case of Morayshire samples of all the eight varieties of oats grown on each of the three farms where the experiment was carried on, or twenty-four samples in all, were analysed. In the case of Aberdeenshire only four varieties, Scots Birlie, Wide Awake, Siberian and Thousand Dollar, which were not analysed in the previous year, were taken for analysis, and samples of these were obtained from four different farms—Tulloch, Mains of Cairnbulg, Corsiestone and Fintry—making sixteen samples in all. In every case the samples sent for analysis were average samples of the dressed grain of the variety and farm in question. Straw samples from each farm were not analysed, but as in the previous year composite samples, representative of the average of each variety from three farms in Morayshire and from the four chosen farms in Aberdeenshire, were made up for analysis. These twelve representative samples were prepared by the method described in Bulletin No. 2, p. 33.

Composition of the Grain.

As in the case of the crop of 1903, the proportion of husk to kernel in the grain and the composition of the kernel were determined. The methods by which these determinations were made were similar to those previously used, and are described in Bulletin No. 2. The separation of husk and kernel was again made laboriously by hand, and all determinations were made in duplicate. The following tables give the results:—

TABLE X.

Oats—Season 1904.

Percentages of Husk and Kernel in Air-dried Samples.

MORAYSHIRE.

Variety.	Linksfield.		Surradale.		Myreside.		Average.	
	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.
Potato	76·88	23·01	77·73	22·06	76·49	23·39	77·03	22·82
Goldfinder	76·69	23·19	76·24	23·39	75·17	24·52	76·03	23·70
Wide Awake	74·74	25·18	75·61	24·04	73·07	26·32	74·47	25·18
Newmarket	73·21	26·71	76·46	23·32	73·46	26·43	74·37	25·48
Thousand Dollar	73·17	26·81	75·39	24·37	73·56	26·39	74·04	25·86
Banner	73·07	26·70	74·98	24·81	73·25	26·41	73·76	25·97
Siberian	72·23	27·61	74·87	24·92	73·60	25·40	73·58	25·97
Colossal	72·38	27·58	74·42	25·22	72·22	27·65	73·00	26·81

TABLE XI.

Oats—Season 1904.

Percentages of Husk and Kernel in Air-dried Samples.

ABERDEENSHIRE.

Variety.	Tulloch.		Mains of Cairnbulg.		Corsiestone.		Fintry.		Average.	
	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.	Kernel.	Husk.
Scots Birlie . . .	75·98	23·88	76·65	23·31	75·30	24·35	—	—	75·98	23·84
Siberian	75·63	24·28	75·81	24·05	75·24	24·35	76·21	23·73	75·72	24·10
Thousand Dollar . .	75·77	23·83	74·90	25·00	75·17	24·60	76·21	23·67	75·51	24·27
Wide Awake . . .	73·94	25·74	74·96	24·95	74·65	24·66	—	—	74·51	25·11

TABLE XII.

Oats—Season 1904.

Percentages of Husk and Kernel in Air-dried Samples.

ABERDEENSHIRE AND MORAYSHIRE.

Variety.	Average.	
	Kernel.	Husk.
Thousand Dollar	74·77	25·06
Siberian	74·65	25·06
Wide Awake	74·49	25·14

In all the tables the results are arranged in order of the average percentage of kernel, so that those varieties which give the highest average percentage of kernel are placed at the top, and those giving the lowest percentage are at the bottom.

Table IX. shows that on every farm in Morayshire Potato oats easily head the list for thinness of husk and high percentage of kernel. This is a complete reversal of the results of 1903. (Bulletin No. 2, p. 27.) In that year Goldfinder, Newmarket and Banner, all of which are now behind Potato, were easily ahead of it. While of the varieties tried in both years only Siberian was behind it in 1903. Whether this difference in results is due to differences in the seasons or to other causes we have not sufficient data to determine. These results illustrate the danger of drawing general conclusions on matters of this kind except after long continued experiment. Generally speaking all the varieties tried this year show only comparatively slight differences in the proportions of husk and kernel. There is no variety like Storm King in the experiments of 1903, which contains a notably greater or less proportion of husk than any of the others. Potato, Goldfinder and Scots Birlie all contain less than a quarter of their weight of husk. The others all contain about a quarter of their weight or a little over it. The transition from one to the other is gradual, and several of them are very close together.

Composition of Kernels.

The composition of the kernels was determined as in the preceding year (p. 29, Bulletin No. 2). In every case the composition was determined in a completely dry sample. It shows what the composition of pure husk-free oatmeal, prepared from the oat in question, would be.

In the following tables the varieties are arranged according to the percentages of oil which on the average they contain. The variety which gives the highest average percentage of oil is placed top in each table, and the others follow in order. As was pointed out in Bulletin No. 2, the albuminoids and oil are the most valuable constituents of food, and those varieties which contain the largest percentages of these may be looked upon as of highest food value.

In 1903 it was found that Potato and Sandy were easily ahead of all the other varieties analysed, with the exception of Hamilton, in percentage of oil, and also ahead of all the varieties, with the exception of Storm King, in percentage of albuminoids. In fact the old varieties Potato and Sandy were found to yield, on the average, oatmeal of distinctly higher quality as food than the new varieties yielded. In 1904 Potato was analysed only in the case of Morayshire, Table XII. It is again high up for quality, but its superiority is not so marked as it was in the samples grown in the dull, damp season of 1903. It is much poorer in oil, and only a little better in albuminoids than in 1903. It is easily beaten in both by Colossal, an oat which was not tried in the experiments of 1903. All the varieties which were tried in 1903 as well as 1904 are, on the average, higher in albuminoids in 1904 than in 1903. On the other hand, while Potato is lower in oil in 1904 than in 1903, most of the new varieties are higher.

The composition of the Aberdeenshire samples which we were able to analyse is given in Table XIII. The old variety Scots Birlie easily leads in average percentage of oil and albuminoids. It is noticeable that the Aberdeenshire are distinctly lower in albuminoids than the Morayshire samples. This result applies to all the different farms. The percentages of oil found in the samples from the two counties do not differ very widely from one another.

TABLE XIII.

Composition of Oat Kernels—Dry.

MORAYSHIRE—Season 1904.

Variety.	Linksfield.					Surradale.					Myreside.					Average.				
	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.
Colossal . .	8·58	18·53	66·30	3·26	3·33	7·50	17·18	69·81	3·16	2·35	8·63	15·03	68·79	3·56	3·99	8·23	16·91	68·30	3·32	3·22
Potato . .	8·72	16·31	69·53	3·19	2·25	7·40	15·93	70·57	3·30	2·80	7·68	15·59	70·61	3·67	2·45	7·93	15·94	70·25	3·38	2·50
Siberian . .	7·77	14·55	72·40	3·16	2·12	6·40	14·99	73·48	3·32	1·81	7·47	14·99	72·83	3·29	1·42	7·21	14·84	72·90	3·25	1·78
Banner . .	6·52	16·72	71·64	3·14	1·98	6·37	13·66	74·37	2·97	2·63	8·44	13·80	71·55	3·77	2·44	7·11	14·72	72·52	3·29	2·35
Newmarket .	7·95	15·44	70·84	3·06	2·71	6·24	15·81	72·24	3·04	2·67	7·02	15·68	71·56	3·30	2·44	7·07	15·64	71·56	3·13	2·60
Thousand Dollar	7·04	14·50	72·70	3·08	2·68	6·22	15·59	71·83	3·14	3·22	6·91	15·65	71·64	3·27	2·53	6·72	15·24	72·09	3·16	2·81
Wide Awake .	7·32	15·90	71·81	3·02	1·95	6·20	15·97	72·34	3·20	2·29	6·31	14·86	72·31	3·60	2·92	6·61	15·57	72·15	3·27	2·38
Goldfinder . .	6·39	15·56	72·81	3·04	2·20	5·79	16·03	72·88	3·03	2·27	6·37	16·24	71·44	3·37	2·58	6·17	15·94	72·38	3·14	2·35

TABLE XIV.

Composition of Oat Kernels—Dry.

ABERDEENSHIRE—Season 1904.

Variety.	Tulloch.					Mains of Cairnbulg.					Corsiestone.					Fintry.					Average.				
	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.	Oil.	Albuminoids.	Soluble Carbohydrates.	Crude Fibre.	Ash.
Scots Birlic .	8·65	14·25	71·82	3·13	2·15	8·34	14·22	71·47	3·27	2·70	8·41	12·21	74·37	2·83	2·18						8·46	13·56	72·56	3·08	2·34
Wide Awake .	8·00	12·67	74·63	2·58	2·12	7·52	12·09	75·14	2·89	2·36	6·90	12·44	75·24	2·92	2·50						7·47	12·40	75·00	2·79	2·32
Thousand Dollar .	6·95	12·28	76·07	2·61	2·09	6·73	13·09	75·74	2·25	2·19	7·29	13·65	74·14	2·94	1·98	6·75	12·90	75·36	2·60	2·39	6·93	12·98	75·33	2·60	2·16
Siberian .	7·16	11·81	75·62	3·09	2·32	6·76	11·87	76·49	2·86	2·02	6·40	14·50	74·09	2·94	2·07	6·25	12·00	75·54	3·62	2·59	6·64	12·54	75·44	3·13	2·25

TABLE XV.

Composition of Oat Kernels—Dry.

Average of Three Varieties from Aberdeenshire and Morayshire.

Variety.	Oil.	Albuminoids.	Soluble Carbo-hydrates.	Crude Fibre.	Ash.
Wide Awake . .	7·04	13·98	73·58	3·03	2·36
Siberian . . .	6·92	13·19	74·18	3·19	2·01
Thousand Dollar .	6·82	14·11	73·70	2·88	2·48

In general these analyses, like those of the previous year, show that the old varieties yield oatmeal of somewhat richer quality than that yielded by the new varieties, though this year there is an exception in the case of Colossal.

Composition of Straw.

Analyses were made of composite samples of straw of all the different varieties, the grain of which was analysed. Separate samples of straw from all the different farms were not analysed, but composite samples were made representing the straw of all the farms of Morayshire and Aberdeenshire respectively from which grain samples were analysed.

The samples were mixed and prepared, and the analyses were made as already described in Bulletin No. 2, pp. 33 and 34. As there pointed out, the value of the straw as a food is indicated principally by the percentages of albuminoids and fibre. The higher the albuminoids and the lower the fibre the better, generally speaking, the straw.

In the following tables the varieties are arranged according to the percentage of albuminoids which they contain.

TABLE XVI.

Composition of Oat Straw—Season 1904.

MIXED SAMPLES FROM MORAYSHIRE.

Variety.	Moisture.	Dry Matter.				
		Albuminoids.	Crude Fibre.	* Ash.	Soluble Carbo-hydrates, etc., by Difference.	* Containing Siliceous Matter.
Wide Awake .	14·2	4·53	38·85	4·95	51·67	0·81
Goldfinder .	14·3	3·99	38·80	5·30	51·91	0·77
Colossal . .	13·40	3·74	40·00	4·20	52·06	0·80
Potato . .	13·90	3·68	39·25	4·26	52·81	0·88
Newmarket .	14·30	3·37	40·40	4·75	51·48	0·82
Siberian . .	14·20	3·18	40·90	5·15	50·77	1·14
Thousand Dollar	15·70	2·90	39·75	5·60	51·75	0·98
Banner . .	13·30	2·31	44·30	4·40	48·99	0·80

TABLE XVII.

Composition of Oat Straw—Season 1904.

MIXED SAMPLES FROM ABERDEENSHIRE.

Variety.	Moisture.	Dry Matter.				
		Albuminoids.	Crude Fibre.	* Ash.	Soluble Carbo-hydrates, etc., by Difference.	* Containing Siliceous Matter.
Wide Awake .	14·7	3·22	40·35	5·55	50·88	1·74
Siberian . .	17·3	3·16	39·30	5·95	51·59	1·50
Scots Birlie .	14·7	2·58	36·80	5·50	55·12	0·67
Thousand Dollar	14·3	2·35	35·45	5·15	57·05	2·20

TABLE XVIII.

Composition of Oat Straw—Season 1904.

AVERAGE OF SAMPLES FROM ABERDEENSHIRE AND MORAYSHIRE.

THREE VARIETIES.

Variety.	Moisture.	Dry Matter.				
		Albuminoids.	Crude Fibre.	* Ash.	Soluble Carbohydrates, etc., by Difference.	* Containing Siliceous Matter.
Wide Awake .	14·45	3·87	39·60	5·25	51·27	1·27
Siberian . .	15·75	3·17	40·10	5·55	51·18	1·32
Thousand Dollar	15·00	2·62	37·60	5·37	54·40	1·59

As in the case of the straws analysed in the previous year, the analyses recorded in these tables do not lead to any very clear conclusions. There is more difference between the best and the worst this year, both in albuminoids and in fibre, than in 1903. The four varieties from Morayshire which are common to the two years, Potato, Newmarket, Siberian and Banner, are in very much the same order in both years. But whereas Potato was top in 1903, three varieties which were not tried in 1903 are ahead of it in 1904. Altogether the albuminoids are rather lower in 1904 than in 1903 for the same varieties. It is also noticeable that albuminoids are higher in the Morayshire than in the Aberdeenshire straws. There is no reason from the analyses of straws made in 1903 and 1904 for concluding that the straws of the new varieties are of lower feeding quality than those of old varieties like Potato and Scots Birlie.

In conclusion we have to express our thanks to Messrs. W. J. Profeit, M.A., B.Sc., and H. M. Will, M.A., B.Sc., for their assistance with the analytical work.

NOTE OF ACKNOWLEDGMENT.

Thanks are due to the occupants of the farms named in the Report, who gave the use of their land, free of charge, for the purposes of the experiments, and who incurred much trouble and some expense in their supervision and execution.

Aberdeen and North of Scotland
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Bulletin No. 7

REPORT

ON THE

SPROUTING OF SEED POTATOES

1906

BY

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AND

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BOXING AND SPROUTING SEED POTATOES, 1906.

FIELD trials to ascertain what advantage, if any, resulted from the use of seed which had been boxed and sprouted were carried out in the North of Scotland in 1905. The returns, which were very favourable to the method of sprouting, except with one or two varieties at one centre in Ross-shire, were published in Bulletin 3 of the College.

The sprouting or boxing of early varieties has been successfully in vogue for many years, and even the same method of preparing the seed of late varieties has now passed the experimental stage and may be confidently recommended on most soils and in most districts suitable for potato growing.

The area of the potato crop in the North-East of Scotland is comparatively insignificant, but the soil and climate (except in the latest districts) are quite suitable for main crop and late varieties, and if the production can be profitably increased by the sprouting method there is no reason why it should not be adopted, even if the area is small and the market limited.

The tests of 1905 have been continued in 1906 in order to confirm the results of the former year and to demonstrate in other localities the utility of the method. The trials were made on the farms mentioned below, and in addition to the seed provided by the College a variety generally grown by the experimenter was put in the test. The "Home Seed" used at each place is noted in the last column of Table I. Another field trial under most careful conditions was specially made at Cullisse, Ross-shire, to ascertain the accuracy of the results obtained on that farm in 1905. This experiment, which is of exceptional interest, is separately reported on at page 15.

TABLE I.

FARMS AT WHICH THE TRIALS WERE CARRIED OUT.

OCCUPIER.	FARM.	DISTRICT.	HOME SEED.
Mr. Robert Milne . .	Wester Durris	Drumoak	Up-to-Date
,, Alex. Reid . .	Torryleith	New Machar	Champion
,, Peter Mennie . .	Wellside	Premnay, Insch	—
,, John Hutcheon .	Doune Park	Banff	Dalmeny Beauty
" Alex. Adam . .	Kinneddar	Lossiemouth	Up-to-Date
*Major Macdonald .	Keppoch	Roy Bridge	—

Six of the varieties on Table II. were obtained from Dolphingstone, East Lothian, where they were grown. Twenty-eight lbs. of each variety were sent to each experimenter, and 14 lbs. were sprouted in the usual way in trays or boxes provided for the purpose; the remainder of the sets were planted unsprouted.

In districts where early potatoes are grown the sets are usually boxed in the autumn or early winter, when the crop is lifted, or shortly after. This procedure is somewhat inconvenient when the weather for potato-lifting is uncertain, and if sprouting is to succeed in late districts it must be in spite of the boxing taking place in winter or early spring.

The boxing for these trials took place in February or March, so that in some cases the sets had less than six weeks to grow before being planted. The results are all the more significant in view of this short period. As a rule, the same number of sets were planted, and as nearly as possible the same weights. The manuring conditions were exactly similar for each variety at each centre, but would, of course, vary considerably between one centre and another. The seed was all planted on the same day at the usual time for planting potatoes in the district in which the trial was made, and the resulting crops were lifted on the same day.

* Owing to delay in the carriage of the seed this experiment was not completed.

TABLE II.

Showing the Average Total Produce of Potatoes from Sprouted and Ordinary Seed of Each Variety and the Total Gain by Sprouting.

Variety.	Sprouted.		Unsprouted.		Gain by Sprouting.	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
Ninetyfold . . .	6	8½	4	14½	1	14
Table Talk . . .	12	3½	10	11	1	12½
Up-to-Date . . .	12	0½	10	9	1	11½
Home Seed . . .	12	1¾	10	10½	1	11¼
Factor	12	4½	10	19½	1	5
Northern Star . .	10	11¼	9	6¼	1	5
Eldorado . . .	9	3½	8	0½	1	3
Average . .	10	13	9	4	1	9

The above Table shows that every variety has given a larger produce by sprouting, of at least 1 ton per acre, and the average increase for all the varieties is 29 cwt.

In 1905, 47 plots out of 56 showed the superiority of the sprouting method. In 1906 the trials under discussion gave evidence of the superiority 37 times out of 39. The exceptions were Dalmeny Hero at one farm, and "Home Seed" at another, and these may be looked upon as due to some slight difference in the soil or some accident to the seed. The results are therefore even more conclusive than in the previous year, especially when it is remembered that the potatoes were in the boxes less than six weeks in some cases.

TABLE III.

Showing the Average Produce of Marketable Potatoes, and the Gain of Marketable Potatoes by Sprouting (Three Centres only).

Variety.	Sprouted.		Unsprouted.		Gain by Sprouting.	
	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.
Northern Star	10	0½	7	12	2	8½
Up-to-Date	11	1	8	13½	2	7½
Ninetyfold	5	0	3	0½	1	19½
Factor	10	5	8	11¾	1	13¼
Table Talk	10	0¾	8	13¼	1	7½
Eldorado	7	0	5	17½	1	2½
Home Seed	9	12	8	11	1	1
Average	9	0	7	5¾	1	14¼

The advantage of sprouting is more apparent when the marketable potatoes are considered, but as only three centres are available for comparison the details on Table II. from five centres cannot be set against those on Table III. It is noticeable that Northern Star and Up-to-Date give the largest returns of marketable potatoes. In 1905 those two varieties also produced 2 tons more of marketable potatoes by sprouting.

TABLE IV.

SHOWING THE PERCENTAGE OF SMALL AND DISEASED TUBERS FROM EACH VARIETY (AVERAGE OF THREE CENTRES).

VARIETY.	PERCENTAGE OF SMALL.		PERCENTAGE OF DISEASED.	
	SPROUTED.	UNSPROUTED.	SPROUTED.	UNSPROUTED.
Eldorado . .	26·5	28·6	0·4	0·2
Northern Star .	17·7	24·9	0·2	0·4
Ninetyfold . .	19·2	16·2	10·0	17·6
Factor . . .	13·6	17·1	1·0	4·0
Up-to-Date - -	11·8	14·5	2·5	6·4
Table Talk . .	17·8	17·4	2·3	3·9
Home Seed . .	18·8	17·7	1·5	4·1
Average .	17·9	19·5	2·4	5·2

As in 1905 so in 1906, the average percentage of small and diseased potatoes is less by the sprouting system, and the percentage of diseased tubers is 2·4 from the boxed seed and 5·2, or more than double, from the ordinary seed.

THE EFFECT OF SPROUTING IN DIFFERENT DISTRICTS.

It was noticeable in 1905 that the largest returns from sprouting were obtained from the latest districts. The same cannot be said of the results in 1906, for the largest and smallest gains were got from the best land in a good climate, namely, at Doune Park, in Banffshire, and at Lossiemouth, in Morayshire.

	Gained by Sprouting. Tons.	Cwts.
Wester Durris, Kincardineshire	0	19
Wellside, Premnay, Insch, Aberdeenshire . .	1	4
Torryleith, New Machar, Aberdeenshire . .	1	14
Doune Park, Banffshire	0	15
Kinneddar, Lossiemouth, Morayshire . . .	2	9

The Effect of Planting at Different Dates.

In a late spring, when the land is unfit to work, there is a temptation to cultivate too soon and plant when the soil and weather are unfavourable, in the fear that to postpone the planting much beyond the usual time will result in a partial failure of crop. It is generally considered an advantage of the sprouting system that it admits of planting later than usual without a diminution of crop. To demonstrate this advantage the following gentlemen were kind enough to carry out with their own seed the test to be described below :—

C. M. Bruce, The Langcot, Forres.
W. Rose Black, Sheriffston, Elgin.
W. Brown Robertson, Coleburn, Longmorn.
George A. Ferguson, Surradale, Elgin.

From 1 to 2 cwt. of sprouted seed were planted beside an equal quantity of unsprouted tubers, and a fortnight later the same weights of sprouted and unsprouted tubers were planted beside the first lots. We have thus four comparisons or tests, *viz.* :—

a. Between sprouted and unsprouted seed.
b. Between sprouted seed planted early and unsprouted seed planted later.
c. Between unsprouted seed planted early and late; and
d. Between unsprouted seed planted early and sprouted seed planted late.

Sprouted Seed *Versus* Unsprouted Seed (See Table V.).

At all centres except Surradale there is a considerable gain by sprouting. At Surradale the crops by the two methods were practically the same. On the whole we have thus a general confirmation of the results described in the first part of the report.

TABLE V.

Showing the Effect of Sprouted Seed when Planted Either Early or Late.

LANGCOT, FORRES.

	Planted.	Produce per Acre.		Gain by Sprouting.	
		Tons.	Cwt.	Tons.	Cwt.
Unsprouted	26th April	5	2	—	
Sprouted	—	6	10	1	8
Unsprouted	10th May	4	10	—	
Sprouted	—	6	5	1	15
SHERIFFSTON, ELGIN.					
Unsprouted	16th April	12	5	—	
Sprouted	—	16	15	4	10
Unsprouted	30th April	15	18	—	
Sprouted	—	16	12	0	14
COLEBURN, LONGMORN.					
Unsprouted	10th April	3	16	—	
Sprouted	—	4	0	0	4
Unsprouted	25th April	7	17	—	
Sprouted	—	8	5	0	8
SURRADALE, ELGIN.					
Unsprouted	21st April	11	10	—	
Sprouted	—	11	8	0	2 (decrease)

Sprouted Seed Planted Early and Later (See Table VI.).

As there are in this case only three centres providing information, average figures are misleading and the results from each

farm must be considered. At Langcot and Sheriffston the early planting produced a few more hundredweights than the later planting, but the difference is very slight and seems to indicate that, provided the seed is sprouted, the planting may be delayed a fortnight without much diminution of crop. At Coleburn, however, the late crop was more than double the early one. Mr. Brown Robertson accounts for this result by the fact that at the time of early planting the ground was cold and wet and the weather unfavourable.

Unsprouted Seed Planted Early and Later (See Table VI.).

The late planting of ordinary seed at Sheriffston and Coleburn has done best, but at Langcot the early planting has produced the larger crop, chiefly owing to a greater proportion of small potatoes.

TABLE VI.

Showing the Effects of a Fortnight's Interval in Planting.

	Planted.	Langcot.		Sheriffston.		Coleburn.	
		Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.
Sprouted . . .	Early	6	10	16	15	4	0
Do. . . .	14 Days Later	6	5	16	12	8	5
Unsprouted . .	Early	5	2	12	5	3	16
Do. . . .	14 Days Later	4	10	15	18	7	17

Unsprouted Seed Planted Early Compared with Sprouted Seed Planted Later.

We now come to the real object of the test, *i.e.*, whether sprouting will counterbalance late planting. To be certain in our conclusions, however, the test must include the ordinary seed planted later or we may make the mistake of supposing that an augmented crop is due to sprouting only.

TABLE VII.

Showing the Effect of Using Sprouted Seed Planted a Fortnight Later than Ordinary Unsprouted Seed.

LANGCOT.

	Planted.	Tons.	Cwt.	Gain by Sprouting over Ordinary Seed Planted Early. Tons.	Cwt.	Gain by Sprouting over Ordinary Seed Planted Later. Tons.	Cwt.
Unsprouted Seed .	Early	5	2	—		—	
Unsprouted Seed .	Later	4	10	—		—	
Sprouted Seed .	,,	6	5	1	3	1	15

SHERIFFSTON.

	Planted.	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.
Unsprouted Seed .	Early	12	5	—		—	
Unsprouted Seed .	Later	15	18	—		—	
Sprouted Seed .	,,	16	12	4	7	0	14

COLEBURN.

	Planted.	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.
Unsprouted Seed .	Early	3	16	—		—	
Unsprouted Seed .	Later	7	17	—		—	
Sprouted Seed .	,,	8	5	4	9	0	8

The gain by planting sprouted seed late over unsprouted seed planted early is enormous (*viz.*, 1 ton 3 cwt., 4 tons 7 cwt., and 4 tons 9 cwt.), and but for the precaution referred to above the increase might have been misinterpreted. It is clear that at Sheriffston and Coleburn it is due more to planting later than to sprouting. Apparently the spring of 1906 in Morayshire was unfavourable to early planting, but it is strange that fourteen or fifteen days interval in the time of planting should make so much difference to the resulting crop. The sprouting has given increases of 35 cwt., 14 cwt., and 8 cwt. at Langcot, Sheriffston and Coleburn respectively, but it is probable that some of the ordinary

seed had sprouted by the end of April and beginning of May, and in that case the comparatively small returns are not so surprising. The results are, on the whole, distinctly favourable to the assumption that later planting of boxed seed will counterbalance early planting of ordinary seed, but they are not conclusive, and the trials must be repeated.

Manuring of Potatoes.

Associated with the sprouting tests described in the first part of the Report were a number of plots treated with different combinations of artificial manures. The purpose of the manurial plots was to demonstrate to those who were interested in potato-growing, the well-known effects of the three important manurial ingredients, nitrogen, phosphates and potash, upon the potato crop.

There is no reason to believe that the North of Scotland differs from the rest of the country in its soil requirements with regard to the potato, and the results of a simple test made at six widely scattered centres in 1906 remove any doubt upon the subject, so far as the effects of potash are concerned.

Five plots, each $\frac{1}{16}$th of an acre in extent, received in turn no manure, a complete manure containing 20 lb. of nitrogen, 60 lb. of phosphoric acid, and 80 lb. of potash, and the same application, but with potash, phosphates and nitrogen omitted from Plots 3, 4, and 5 respectively.

The returns practically confirm each other in every particular, and with almost no inconsistency, so that it is permissible to attend to the averages only, though the total crop grown on each farm is given on Table X.

TABLE VIII.

SHOWING THE EFFECTS OF USING A COMPLETE ARTIFICIAL MANURE AND OF OMITTING NITROGEN, PHOSPHATES AND POTASH IN TURN FROM THE MIXTURE.

PLOT.	TREATMENT.	PRODUCE PER ACRE.		INCREASE DUE TO MANURES.	
		Tons.	Cwts.	Tons.	Cwts.
1.	No Manure	5	14	—	
2.	$1\frac{3}{8}$ cwt. Sulphate of Ammonia . $3\frac{3}{4}$ cwt. Superphosphate . . $1\frac{1}{2}$ cwt. Muriate of Potash . .	10	15	5	1
3.	$1\frac{3}{8}$ cwt. Sulphate of Ammonia . $3\frac{3}{4}$ cwt. Superphosphate . . **No Potash**	7	10	1	16
4.	$1\frac{3}{8}$ cwt. Sulphate of Ammonia . $1\frac{1}{2}$ cwt. Muriate of Potash . . **No Phosphates**	8	19	3	5
5.	$3\frac{3}{4}$ cwt. Superphosphate . . $1\frac{1}{2}$ cwt. Muriate of Potash . . **No Nitrogen**	9	8	3	14

The effect of potash on the percentage of small potatoes is very striking. In all cases the proportion of small potatoes on Plot 3 from which potash has been omitted is very much greater than on Plot 2 which receives the complete manuring (see Table IX.).

TABLE IX.

SHOWING PERCENTAGE OF SMALL POTATOES TO TOTAL PRODUCE (THREE CENTRES).

	DOUNE PARK.	KINNEDDAR.	ROOTFIELD.	AVERAGE.
No Manure . . .	44·0	27·1	24·3	31·8
Complete Manure . .	28·8	23·8	13·2	21·9
No Potash . . .	52·2	28·4	17·0	32·5
No Phosphate . . .	28·4	26·2	21·6	25·4
No Nitrogen . . .	34·2	23·8	20·3	26·1

R. B. G.

TABLE X.

Showing the Produce of Potatoes at Each of Five Centres.

	Plot 1. No Manure.			Plot 2. Complete Manure.			Plot 3. No Potash.			Plot 4. No Phosphate.			Plot 5. No Nitrogen.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.	Marketable.	Small.	Total.	Marketable.	Small.	Total.	Marketable.	Small.	Total.
	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.
Doune Park .	3 1½	2 8½	5 10	8 15¾	3 11¼	12 7	3 6½	3 12	6 18½	5 12¾	2 5¼	7 18½	5 18½	3 1½	9 0
Kinneddar . .	7 8¼	2 16	10 7⅛	9 12½	3 2	12 19⅞	8 5½	3 7⅛	11 15⅞	9 1	3 5⅞	12 11⅜	8 16	2 13⅛	11 16¼
Eastertown of Torryleith .	2 0¼	0 7¾	2 8	8 16⅞	0 13⅞	9 10¾	5 14¼	0 14¾	6 9	—	—	—	—	—	—
Wester Durris .	—	—	5 7½	—	—	11 12¼	—	—	6 5½	—	—	10 6½	—	—	10 8½
Wellside . .	—	—	1 19	—	—	6 9¾	—	—	3 6	—	—	3 7¼	—	—	5 4½
Rootfield . .	6 13⅞	2 2⅞	8 16¾	9 12⅞	1 11¼	11 14⅛	9 2¼	1 17½	10 19¾	8 6	2 5⅞	10 11⅞	8 8½	2 2⅞	10 11⅜
Average .			5 14			10 15			7 10			8 19			9 8

POTATO EXPERIMENTS IN ROSS-SHIRE.

As the Ross-shire experiment on the sprouting of seed pototoes in 1905 showed a profitable increase by sprouting in half the number only of the varieties under trial, and as these results were considerably at variance with those obtained elsewhere, the Advisory Committee for the county considered it desirable to have the tests repeated in 1906.

Accordingly an almost similar experiment was arranged, and again carried out by Mr. John Gordon, Cullisse.

The seed of all the varieties in the 1906 trials, with the exception of Eureka, was grown at Cullisse the previous year. In the 1905 experiment the seed of most of the varieties was obtained from the South of Scotland. This change was effected because seed taken directly from the South is not considered so reliable as seed obtained from a first crop in the district.

The boxing of seed was accomplished in December, about ten weeks earlier than in the former trials, and the sprouts were further advanced, and more satisfactory in every way, at the time of planting than in 1905.

As in the former trials, the same weight and about the same number of both sprouted and unsprouted sets were used in all the plots. The manurial treatment was exactly similar for all the varieties, and the trials were carried out on soil of uniform quality. The seed was all planted on the same day, and the crops were lifted and weighed on the same day.

TABLE XI.

To Show the Total Returns per Acre and the Total Increase by "Sprouting".

Variety.	Total Yield per Acre from Sprouted Seed.		Total Yield per Acre from Unsprouted Seed.		Total Increase per Acre by Sprouting.	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
Duchess of Cornwall	14	19	12	9½	2	9½
Up-to-Date . .	16	6¼	13	18¼	2	8
King Edward VII. .	12	5¾	10	9	1	16¾
Factor . . .	14	13½	13	18¼	0	15¼
Eureka . . .	10	16½	10	3¼	0	13¼
British Queen . .	10	18¾	10	18¼	0	0½
Peacemaker . .	9	6¾	9	15¾	(0	9 decrease)
Royal Kidney . .	11	17¾	11	19¾	(0	2 decrease)
Northern Star . .	12	5½	12	7	(0	1½ decrease)
Evergood . . .	10	16½	12	1¾	(1	5¼ decrease)
Averages . .	12	8½	11	16	0	12½

It is evident from these returns that some varieties are very differently affected by the seed-sprouting treatment compared with others. Half the number only of the varieties tested show a profitable gain by sprouting, while in four out of ten varieties there is an actual decrease in the total crop. In the case of British Queen the total crops from sprouted and unsprouted seed are about equal.

TABLE XII.

To Show the Yield per Acre of Marketable Potatoes, and the Increase per Acre of Marketable Potatoes by "Sprouting".

Variety.	Yield per Acre from Sprou ed Seed.	Yield per Acre from Unsprouted Seed.	Increase per Acre due to Sprouting.
	Tons. Cwts.	Tons. Cwts.	Tons. Cwts.
Duchess of Cornwall	14 15¼	11 16¼	2 19
Up-to-Date . .	15 7	12 17¼	2 9¾
King Edward VII. .	11 8½	9 13¾	1 14¾
Factor . . .	14 2	13 3	0 19
Eureka . . .	10 9	9 13¾	0 15¼
British Queen . .	9 19½	9 11½	0 8
Peacemaker . .	8 17¼	8 16½	0 0¾
Royal Kidney . .	10 14¾	10 16¾	(decrease 0 2)
Northern Star . .	11 4½	11 7½	(decrease 0 3)
Evergood . . .	9 17	11 2½	(decrease 1 5½)
Averages . .	11 13¼	10 17¾	0 15½

The chief advantages claimed for sprouting are, that it reduces the quantity of small potatoes and increases the saleable potatoes. In these trials the effect of sprouting on the marketable potatoes is well shown in Table XII. In the first six varieties, which respond to the boxing treatment, the gains (Table XII.), although largely, are not wholly due to an increase in the size of the marketable potatoes. The increased gains that are observed, by comparing the weights in the last column of Table XI. with those in the last column of Table XII., are due to the effects of sprouting on the small potatoes. The average yield of small potatoes from the sprouted seed of the suitable varieties is 13 cwt., while from the

unsprouted seed it is 17 cwt.—a gain of 4 cwt. for the sprouted seed.

A similar result was obtained in 1905.

TABLE XIII.

To Show the Results of "Sprouting" at Cullisse in 1905 and 1906.

Variety.	Total Increase per Acre by Sprouting in 1905.	Total Increase per Acre by Sprouting in 1906.
	Tons. Cwts.	Tons. Cwts.
Duchess of Cornwall	3 1¾	2 9½
Up-to-Date	1 4	2 8
King Edward VII.	1 1½	1 16¾
Factor	1 4½	0 15¼
British Queen	(0 9¼ decrease)	0 0½
Royal Kidney	(0 19½ decrease)	(0 2 decrease)
Northern Star	0 3½	(0 1½ decrease)
Evergood	(0 13 decrease)	(1 5¼ decrease)
Average Increase on all Varieties	0 11¾	0 16¾

In general the results in the 1906 trials are confirmative of those obtained in 1905. In both experiments, Duchess of Cornwall, Up-to-Date, King Edward VII. and Factor distinctly favour sprouting; while Royal Kidney and Evergood give the largest crops from unsprouted seed. With British Queen and Northern Star the results of 1905 are reversed by those of 1906.

TABLE XIV.

To Compare the Total Crops of Varieties Grown in 1905 with the Total Crops of the same Varieties in 1906.

Variety.	Average Yield from Sprouted and Unsprouted Seed in 1905.		Average Yield from Sprouted and Unsprouted Seed in 1906.		Increase in 1906.	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
Duchess of Cornwall .	9	11½	13	14¼	4	2¾
Up-to-Date . . .	10	7¾	15	2¼	4	14½
King Edward VII. .	8	11¾	11	7¼	2	15½
Factor	10	6¼	14	5¾	3	19½
British Queen . .	8	4¾	10	18½	2	13¾
Royal Kidney . .	9	10¾	11	18¾	2	8
Northern Star . .	9	11½	12	6¼	2	14¾
Evergood . . .	8	17½	11	9	2	11½
Averages . .	9	7¾	12	12½	3	4¾

It is interesting to note how the crops from the two methods of seed treatment are affected by somewhat altered conditions.

If we compare the average crop of all the varieties grown in 1905 with that of the same varieties grown in 1906, the latter exceeds the former by 3 tons 4¾ cwts. (Table XIV.). The season, the use of home seed, improved sprouting, and somewhat more suitable soil are no doubt all accountable in part for this large increase.

Under conditions more favourable to the potato crop generally, sprouted seed appears to benefit even more than unsprouted seed. This is shown by comparing the gains from sprouted seed in both experiments in Table XIII. There the average increase in 1906 exceeds that in 1905 by 5 cwt. per acre.

In conclusion, while these trials demonstrate the unsuitableness for seed sprouting, in Easter Ross at least, of a few varieties of potatoes that are little grown in the district, they are also so far favourable to the sprouting treatment with varieties of potatoes that are largely grown, as to give considerable promise to growers of increased profits from the adoption of the boxing and sprouting of seed of suitable varieties of potatoes.

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Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 8

REPORT

ON

THE RELATIVE EFFECTS OF MANURING WITH SUPERPHOSPHATE AND BASIC SLAG ON THE FEEDING VALUE OF TURNIPS

NOTES ON THE PRESERVATION OF EGGS IN WATER-GLASS

BY

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THE RELATIVE EFFECTS OF MANURING WITH SUPERPHOSPHATE AND BASIC SLAG ON THE FEEDING VALUE OF TURNIPS.

Comparatively few experiments have been made on the effects of different manures upon the composition and feeding quality of crops, though frequently one finds that practical men hold strong and often contradictory opinions on such subjects. As a rule in manuring experiments the result is measured entirely by weight of crop yielded and no account is taken of the important effects which manures may have on quality. The main reason for this is that it is comparatively easy to determine weight, but it is much more difficult to determine the effects which manures have had on quality.

A great many experiments have been carried out in which the two sharply contrasted phosphatic manures, superphosphate and basic slag, have been compared. While in most of these the result has been gauged merely by increase in weight of crop, in recent years there have been a number in which other methods of comparison have been used. The best known among these are the experiments carried out upon poor pasture, first at the Cockle Park Experiment Station in Northumberland, and later at a number of farms in various parts of Scotland. In these experiments the improvement effected in the pasture by the manuring was measured by feeding sheep on the plots, and determining which dressing enabled the plot to carry the greatest number of sheep, and to yield the greatest increase in the weight of the sheep. At Cockle Park the experiments showed results very much in favour of slag. Though the results obtained elsewhere have not

been so remarkable, still on the whole they have been in favour of dressings of slag or of slag and potash.

Much more phosphatic manure is applied to the turnip crop than to any other crop. Numerous experiments have been carried out in which superphosphate and slag have been compared as manures for turnips, but the results have nearly always been measured merely by the increase in weight of crop yielded. In a few cases analyses of the resulting crops have also been made. A few years ago Dr. J. W. Paterson, of the West of Scotland Agricultural College, made some experiments in which the final results were measured by feeding the turnips to sheep, and determining the increase in live weight which resulted. In these experiments the superphosphate grew the bigger crop of turnips, but in every case the sheep fed with the basic slag turnips showed a greater gain in weight. When the increase in weight of sheep as well as the weight of crop was taken into account the result was in every case in favour of basic slag. (See Bulletins, Nos. 15 and 23, West of Scotland Agricultural College.)

In this district cattle feeding is of the greatest importance and turnips are a staple food. From inquiries made it was found that there is a widespread, but by no means universal opinion that slag-manured turnips are not of such good feeding quality as those manured with other fertilisers. It was stated, for instance, that turnips manured with slag caused animals to scour, that they caused the dung to be dark in colour, and that animals fed on such turnips did not thrive well. On the other hand, a few advocates of slag maintained that bulbs grown with slag were sounder than those grown with acid manures, and that animals fed on them throve better. In order to test this point experiments were undertaken in which cattle were fed on turnips manured with superphosphate and basic slag respectively.

It is not so easy or so satisfactory to carry out such experiments with cattle as with sheep. In an experiment with sheep one can use a much larger number of animals than in an experiment with cattle, and therefore any individual peculiarities are much more likely to be lost in the average result. In a sheep experiment, too, turnips can be made a much larger and more important part of the diet, and therefore the result will depend more upon the quality of the turnips than in a cattle experiment.

The experiments described in this paper were carried out by Mr. Bruce, Inschfield, who conducted them during the seasons 1904-5 and 1905-6 and who spared no pains in order to ensure their accuracy.

In both seasons two acres of land as even as possible in quality were marked off for the experiment. Both of these were manured equally with a mixture of nitrate of soda, sulphate of ammonia and potash salts to supply nitrogen and potash, but one was manured with superphosphate and the other with basic slag to supply phosphate. In Dr. Paterson's experiments and in most other experiments equal weights of phosphoric acid in the two forms were used, but in these experiments equal money values of superphosphate and basic slag were applied. The phosphate in basic slag costs less per unit than the phosphate in superphosphate and therefore more of it can be obtained for the same amount of money. In each year 4 cwt. of high grade superphosphate, 38 per cent. soluble, was applied to the superphosphate plot, and an equal money value of a high grade slag, in 1904 $5\frac{1}{2}$ cwt. and in 1906 6 cwt., was applied to the slag plot. The crops per acre for the two years are shown in Table I.

TABLE I.

CROP PER ACRE.

	1904.						1905.					
	Superphosphate.			Slag.			Superphosphate.			Slag.		
	Tons.	Cwt.	Qrs.	Tons.	Cwt.	Qrs.	Tons.	Cwt.	Qrs.	Tons.	Cwt.	Qrs.
Cleaned Bulbs	20	1	2	19	15	2	15	14	3	19	3	1
Tops . .	6	17	0	7	1	2	—			—		
Total . .	26	18	2	26	17	0	—			—		

In both years there was a period of drought after the seed was drilled, and the braird was in consequence somewhat unequal. The crops never quite recovered from this and in both years there were many blanks. Had it not been for this, considerably greater crops would have been obtained. In 1904 the crops from

the two plots were practically equal, but in 1905, although both plots appeared to be equally affected by the drought, the slag plot yielded a considerably greater crop than the superphosphate one.

In both seasons the turnips were taken up and stored in late autumn, and samples were drawn for analysis. Representative samples were obtained by boring a large number of bulbs, at least 100, from each plot and analysing the cores so obtained. In this way a much fairer comparison of the average composition of the crops is obtained than if only a few bulbs were selected and analysed. (See Bulletin No. 4.) In both years the turnips were yellows. The analyses are given in Table II.

TABLE II.

ANALYSIS OF TURNIPS.

	1904.		1905.	
	SUPER-PHOSPHATE.	SLAG.	SUPER-PHOSPHATE.	SLAG.
	Per cent.	Per cent.	Per cent.	Per cent.
Moisture . . .	92·9	92·6	91·40	91·87
Ether Extract . .	0·10	0·08	0·12	0·10
* Nitrogenous Matters	1·05	1·18	0·98	0·95
Soluble Carbohydrates (by difference)	4·29	4·39	5·56	5·37
Fibre	0·97	1·04	1·15	1·01
† Ash	0·69	0·71	0·79	0·70
	100·00	100·00	100·00	100·00
* Containing Albuminoids	0·75	0·85	0·49	0·45
* Containing Amides	0·30	0·33	0·49	0·50
† ,, Siliceous Matter	0·03	0·03	—	—

There are no notable differences in the quality of the turnips as shown by analysis. In 1904 both plots yielded turnips low in solid feeding matter and with a very high percentage of water. In 1905 the turnips contained a higher percentage of dry matter, but are still not of high quality in this respect. There is a great difference in the maturity of the turnips in the two years as

shown by the proportion of the nitrogenous matter which is in the less valuable form of amides. In 1904 over two-thirds of the nitrogenous matter is present in the valuable form of albuminous substances; in 1905 scarcely half is present in this form. This difference however applies to both plots.

In each season twenty cattle were used for the experiment. These were divided into two lots as equally as possible. The two lots were fed equally in all respects, except that the turnips of one lot were from the superphosphate plot and of the other lot from the slag plot. Table III. shows the kinds and amounts of foods fed in each year and the times of feeding.

TABLE III.

Time-table of Feeding.

Time.	1904.	1905.
6 A.M.	40 lb. Turnips. Straw.	40 lb. Turnips. Straw.
10.30 A.M. to 11 A.M.	10 lb. Draff. Mixed Barley and Oats, 2 lb.	10 lb. Draff. Mixed Barley and Oats, 2 lb.
4.30 P.M.	40 lb. Turnips.	40 lb. Turnips.
6 P.M.	2 lb. Linseed Cake.	2 lb. Linseed Cake to smaller cattle (four in each lot). 3 lb. Linseed Cake to larger cattle (six in each lot).

All the foods were analysed and were found to be good of their kind, and they were all supplied by weight. The turnips were sliced and weighed at each feed for each pair of beasts. The weight of straw fed each day was not fixed, but the straw was supplied in weighed bundles, and equal quantities were given to each lot, but an endeavour was made to give the animals approximately as much straw as they would eat. In 1904-5 each lot ate 3,115 lb. or a little over 6 lb. per head per day, and in 1905-6 each lot ate 3,385 lb., or almost $7\frac{3}{4}$ lb. per head per day.

The cattle were ordinary commerical feeding beasts. They were weighed at the beginning of the experiment after one month, and at the end of the experiment. The weights are recorded in Tables IV. and V.

TABLE IV.

Weights of Cattle in First Experiment.

Superphosphate Lot.

No.	5th Jan. Cwt.	5th Jan. Qrs.	5th Jan. Lb.	4th Feb. Cwt	4th Feb. Qrs.	4th Feb. Lb.	25th Feb. Cwt.	25th Feb. Qrs.	25th Feb. Lb.	Increase in 51 Days. Cwt.	Increase in 51 Days. Qrs.	Increase in 51 Days. Lb.
1	6	2	0	7	0	21	7	2	21	1	0	21
2	6	3	0	7	2	21	8	0	0	1	1	0
3	7	0	21	8	0	0	8	1	0	1	0	7
4	7	0	0	8	0	0	8	2	0	1	2	0
5	7	2	14	8	0	14	8	2	14	1	0	0
6	8	1	7	9	0	7	9	1	7	1	0	0
7	8	2	0	9	1	0	9	2	7	1	0	7
8	9	0	7	9	3	7	10	1	0	1	0	21
9	7	3	14	8	1	21	8	3	7	0	3	21
10	8	3	0	9	0	14	9	2	7	0	3	7
Totals	77	2	7	84	2	21	88	3	7	11	1	0
Averages	7	3	1	8	1	25	8	3	15	1	0	14

Slag Lot.

No	5th Jan. Cwt.	5th Jan. Qrs.	5th Jan. Lb.	4th Feb. Cwt.	4th Feb. Qrs.	4th Feb. Lb.	25th Feb. Cwt.	25th Feb. Qrs.	25th Feb. Lb.	Increase in 51 Days. Cwt.	Increase in 51 Days. Qrs.	Increase in 51 Days. Lb.
1	6	2	21	7	1	7	7	3	21	1	1	0
2	7	0	21	8	0	0	8	2	7	1	1	14
3	7	0	19	7	2	21	8	0	14	0	3	23
4	7	2	0	7	3	14	8	2	0	1	0	0
5	7	2	21	8	2	0	8	3	21	1	1	0
6	7	3	21	8	3	21	9	1	14	1	1	21
7	8	2	21	9	2	0	10	0	0	1	1	7
8	8	2	21	9	2	0	9	3	21	1	1	0
9	7	3	0	8	0	14	8	3	14	1	0	14
10	8	0	0	8	1	21	9	0	0	1	0	0
Totals	77	1	5	83	3	14	89	1	0	11	3	23
Averages	7	2	26	8	1	15	8	3	20	1	0	22

TABLE V.

Weights of Cattle in Second Experiment.

Superphosphate Lot.

No.	Date of Weighing. 6th Dec. Cwt.	Qrs.	Lb.	5th Jan. Cwt.	Qrs.	Lb.	19th Jan. Cwt.	Qrs.	Lb.	Increase in 44 Days. Cwt.	Qrs.	Lb.
1	11	1	0	11	3	14	12	0	7	0	3	7
2	11	3	0	12	1	0	12	1	7			7
3	11	1	21	12	0	14	12	1	0		3	7
4	10	2	14	11	0	21	11	1	0	0	2	14
5	10	2	0	11	1	14	11	3	0	1	1	0
6	10	0	0	10	2	0	10	2	14	0	2	14
7	9	3	14	10	2	7	10	2	14	0	3	0
8	8	3	21	9	3	0	10	0	0	1	0	7
9	8	2	21	9	2	0	9	3	0	1	0	7
10	7	2	0	8	1	14	9	2	0	1	0	0
Totals	100	2	7	107	2	0	109	0	14	8	2	7
Averages	10	0	6	10	3	0	10	3	18	0	3	12

Slag Lot.

No.	Date of Weighing. 6th Dec. Cwt.	Qrs.	Lb.	5th Jan. Cwt.	Qrs.	Lb.	19th Jan. Cwt.	Qrs.	Lb.	Increase in 44 Days. Cwt.	Qrs.	Lb.
1	11	1	7	12	1	0	12	1	14	1	0	7
2	12	2	0	12	3	0	13	0	14	0	2	14
3	11	3	0	12	0	21	12	1	14	0	2	14
4	11	0	21	11	2	14	11	3	21	0	3	0
5	10	0	14	10	3	0	11	0	14	1	0	0
6	9	3	14	10	1	21	10	1	21	0	2	7
7	9	0	0	9	2	7	9	2	14	0	2	14
8	8	1	14	9	1	0	9	1	14	1	0	0
9	9	0	7	9	1	21	9	2	14	0	2	7
10	7	2	0	8	0	14	8	1	0	0	3	0
Totals	100	2	21	106	1	14	108	1	0	7	2	7
Averages	10	0	8	10	2	15	10	3	8	0	3	1

In both cases the experiment was continued till the turnips from the plot which yielded the smaller crop were finished, when the final weighing took place. In 1904-5 a small quanity of turnips from the superphosphate plot remained over, and in 1905-6 a large amount, over 3 tons, from the slag plot remained over.

In both years all the animals fed on the turnips from the superphosphate plot remained perfectly healthy and throve all through. In the 1904-5 experiment two of the animals on the slag turnips (Nos. 4 and 9, Table IV.) received hurts at the beginning of the experiment and did not thrive for a time. Table IV. shows that the increase made by them during the first month was below the average. In the 1905-6 experiment, No. 6 of the slag lot went lame towards the end of the experiment and did not thrive. As Table V. shows he made no increase at all between the second and third weighings. All of these mishaps it will be seen happened in the slag lots, but they had nothing to do with the feeding. Their occurrence among the slag cattle must be looked upon as accidental, and as placing this section at a certain disadvantage.

In no case in either year did any of the cattle in the lot fed with slag-manured turnips scour or exhibit any digestive or other trouble which could be ascribed to the food. The dung was examined from time to time, and that of the one lot looked quite as healthy as that of the other, nor could any characteristic difference in colour be noticed. With the exception of the accidents already mentioned, all the animals fed well and throve.

The increases made by the two lots are equal, within the limits of error of such experiments. We cannot expect absolute equality even in two lots fed on identical foods, as different animals vary so much in their feeding and other characteristics. But in these two experiments we have as nearly equal results as we could expect to attain. In the first year the animals fed with the slag turnips made an average increase of 8 lb. more than those fed with the superphosphate turnips, while in the second year the animals fed with the superphosphate turnips made an average increase of 11 lb. more than those fed on the slag turnips. We cannot conclude therefore that either manure produced turnips better than those produced by the other. The fact that the slag produced a much heavier crop than the superphosphate in 1905 was probably acci-

dental. The general result of many experiments made with these two manures on the turnip crop is that for equal quantities of phosphate superphosphate produces on the average a somewhat heavier crop than basic slag, but that for equal values of phosphate they produce approximately equal crops.

In both years the average increase made by all the animals was good. It amounted in 1904-5 to nearly $2\frac{1}{2}$ lb. per head per day for the animals fed with superphosphate turnips and to nearly $2\frac{2}{3}$ lb. for the animals fed with slag turnips. In 1905-6 the increases were not quite so great, as the cattle were not of such good quality. The average increase per beast per day for the superphosphate plot was nearly $2\frac{1}{5}$ lb. and for the slag plot nearly 2 lb.

The general conclusion which may be drawn from these experiments is that turnips grown with basic slag as manure are of quite as good feeding quality as those manured with superphosphate. They do not cause any scouring or other digestive trouble, and the animals fed on them along with other suitable foods, thrive well.

The main trouble of carrying out these experiments fell on Mr. Bruce. The best thanks of the Governors of the College and of myself are due to him for placing his land and cattle at our disposal for the experiments, and for the constant care he exercised and the great amount of trouble he took to ensure their accuracy.

PRESERVATION OF EGGS IN WATER-GLASS.

One of the most popular and commonly used methods of preserving eggs is by means of water-glass. Though this method was introduced only comparatively recently it has largely superseded older methods, and also appears to have led to the much more frequent preservation of eggs on the small scale in households and by small traders. The eggs are obtained when they are plentiful and cheap in spring and preserved for use during the winter months. It is therefore necessary to keep them for about six months in ordinary practice. In the experiments, a short account of which is given below, the object was to discover: (1) whether eggs could be kept in water-glass solution for a long time, such as three or four years, without undergoing any serious change through decomposition or otherwise, which would render them unfit for use; (2) what changes took place in the chemical composition of eggs during preservation, and in particular to find out whether the constituents of the water-glass penetrate the egg.

Water-glass is a mineral compound, known chemically as a silicate of soda, since it is composed of silica, which we have in flint and sand, combined with soda. It is sold as a preservative for eggs in the form of a thick syrup in which the silicate of soda is dissolved in a small proportion of water. Its use as an egg preservative is very simple. One part of the water-glass is dissolved in about twelve to fifteen times its weight of water, and the dilute solution so prepared is poured over the eggs in any suitable vessel. Commercial water-glass varies in strength somewhat. Generally speaking, the stiffer the syrup the stronger the solution of water-glass. A good stiff syrup contains about 50 to 55 per cent. of water-glass and 45 to 50 per cent. of water. When diluted to the strength used for egg preservation it contains about 4 per cent. of water-glass and 96 per cent. of water. Analyses were made of two samples of water-glass used in the experiments and it was found that they contained about 37 per cent. of silica combined

with about 16 per cent. of soda. A mere trace of potash was also present.

Through the kindness of Mr. Clyne, grocer, Gallowgate, Aberdeen, who annually preserves a large number of eggs with water-glass, I was enabled to examine large numbers of eggs which had been preserved in water-glass, and also to set aside small experimental lots of eggs which were kept for one, two or more years as might be required.

In order to preserve eggs under the best conditions they should be put into the water-glass clean and uncracked the same day as they are laid. The eggs used in these experiments were not preserved under such conditions, but were some days old before being put into the water-glass. The eggs were collected in the country and sent up to town in large lots. They were what are technically called "fresh country eggs" but were not technically "new laid eggs". They were of uncertain age and while most of them were not more than two or three days old a few were probably older. Under such conditions the test of the preserving powers of the water-glass was a severe one and it is remarkable that not a single egg in the small experimental lots was ever found to be tainted even when the eggs were three or four years old. The eggs put into the small experimental lots were of course carefully selected. As was to be expected a few bad or tainted or cracked eggs were always found in the big trade lots which were preserved in large tubs. These were probably eggs which were already tainted before they went into the solution, or which were cracked in the process of packing. It was very seldom that a really bad, decomposed egg was found, and most of the unsaleable eggs were cracked eggs.

Mr. Clyne was good enough to keep a note of the total number of unsaleable eggs in certain consignments. For instance, in 1905 out of a lot of 384 dozen preserved between April and June, and sold between October and December, 5 dozen, or 1·3 per cent. were unsaleable. The great majority of these were broken or cracked eggs. Eggs which are preserved in water-glass have a nice appearance, as they look fresh and the shells are clean after the water-glass is wiped off them. Even those which had been several years in water-glass had a fine fresh appearance. Another advantage of preservation in water-glass over certain other

methods is that the contents of the egg do not shrink owing to evaporation. The eggs therefore do not rattle when shaken. On the other hand eggs preserved in water-glass burst their shells when boiled unless they are pricked before being put into the hot water. This is because when kept in water-glass the liquid gradually soaks in through the shell of the egg, so that it is filled quite full and there is no room for the expansion of the contents which takes place when the egg is heated. The pores of the shell also become blocked up through the deposition of silica in them, and this no doubt prevents any escape of gas when the eggs are heated.

The cost of preserving eggs in water-glass is very small as water-glass itself is a cheap substance. Where a considerable number of eggs are preserved the water-glass should not cost more than $\frac{1}{8}$ penny per dozen of eggs.

Eggs kept in water-glass for under a year—and it is seldom necessary to keep them longer than six months—can hardly be distinguished in taste and smell either raw or cooked from ordinary fresh eggs. In fact the eggs appear to come out of the water-glass hardly distinguishable to nose or palate from the state in which they were before they went in. If, however, eggs are kept in water-glass solution for a lengthened period they undergo a gradual change. Four years was the longest period during which the experimental eggs were kept. The white of these eggs when they came out of the water-glass had a pale pink colour and was very liquid. It coagulated in the usual way on beating, but was then of a dusty pink colour. Little change was apparent in the yolk. None of these eggs were bad. Not one had a bad or even a tainted smell, but they all had a slight peculiar taste and smell which suggested soda. They could still quite well have have used for cooking purposes. The eggs three and two years old exhibited similar characteristics, but to a less extent. The amount of change varied with the age. It is evident then that eggs preserved in water-glass do undergo a slow continuous change, but up to one year old the change is so slight as hardly to be distinguishable.

A considerable number of fresh eggs and eggs which had been preserved in water-glass for various periods were analysed. A number of the shells of these eggs were also analysed. The results of most of these analyses are given in Tables I. and II.

TABLE I.

Composition of Eggs—Fresh and Preserved.

	Fresh Eggs.				Preserved Eggs.				
Time in Water-Glass					2 Years.	3 Years.	1 Year.	2 Years.	6 Months.
	Average from König.	3 Eggs.	3 Eggs.	4 Eggs.	Preserved, 1902. Analysed, 1904.	1902. 1905.	1903. 1904.	1903. 1905.	May, 1904. October, 1904.
Moisture	73·67	73·18	72·70	74·44	72·12	74·66	73·55	73·73	—
Nitrogen	2·01	2·11	—	—	2·17	2·10	2·01	2·07	—
Fat .	12·11	10·40	—	—	11·19	9·42	10·70	10·41	—
Ash .	1·12	1·02	* 1·36	1·06	0·92	1·00	0·93	1·02	—
Potash .	0·159	0·120	0·156	0·139	0·075	0·069	0·101	0·073	0·143
Soda .	0·200	0·194	0·173	—	0·296	0·343	0·215	0·311	0·200
Silica .	0·003	0·010	0·021	0·031	0·023	0·019	0·022	0·039	—

* Contained a little carbon.

All the eggs dealt with in these tables were eggs of the ordinary domestic or barn-door fowl. No ducks' eggs or other less common eggs were included in the experiments. In Table I. the average analysis of the fresh eggs of ordinary barn-door fowls is quoted from the standard work of König, in which many analyses from different sources are tabulated. I was not able to discover any records of preserved eggs made by other hands, and the recorded analyses giving the composition of the ash of eggs are very few. The analyses of three different lots of fresh eggs and five different lots of preserved eggs are given. Some of these analyses are incomplete, as owing to an unfortunate accident a considerable part of the records of these experiments were lost.

The analyses show that the preserved eggs are quite similar to the fresh eggs in nearly every respect. The only change in chemical composition is that in the preserved eggs the soda is a little higher than in the fresh eggs and the potash a little lower. But even this change is a very slight one. The solution of water-glass in which the eggs were immersed contains, as was shown above, about $1\frac{1}{4}$ per cent. of soda, but even the eggs which were kept in the solution three years have not increased in soda more than about one-tenth of this amount. In eggs which were kept in water-glass one year or under, the increase in soda is so small as to be indistinguishable from the natural variations which are found in different fresh eggs. It was found that corresponding to the slight increase in soda in the preserved eggs there was a slight increase in alkalinity. Eggs under one year old, however, could not clearly be distinguished in this respect from fresh eggs.

The silica of the water-glass was not found to have passed into the eggs to any appreciable extent. Even the preserved eggs which had been three years in water-glass solution did not contain more silica than fresh eggs.

TABLE II.

Composition of Egg Shells.

Time in Water-Glass Solution.	Fresh.	3 Years.	2 Years.	1 Year.
Moisture	3·45	2·85	3·12	2·95
Organic Matter . . .	5·13	8·47	8·60	4·32
*Ash	91·42	88·63	88·28	92·72
*Containing Lime . .	49·05	48·15	48·15	49·16
Equal to Carbonate of Lime	87·59	85·98	85·98	87·78
Containing Silica . .	0·57	2·32	1·95	1·64
Percentage of Lime in Ash	53·65	54·30	54·54	53·02

Table II. gives the analyses of four samples of egg-shells. One of these was derived from fresh eggs, the others from preserved eggs of different ages as shown in the table. All the samples of shells are quite similar in composition, except that those from the preserved eggs contain more silica than those from fresh eggs. The percentage of silica increases with the length of time the eggs were in the preserving solution. Some silica therefore is deposited in the egg-shells of eggs preserved in water-glass. This is quite without effect on the value of the eggs as food, but will block up the pores of the shells and act as a screen which will prevent other substances gaining access to the contents of the egg.

We may therefore conclude that the composition of eggs is practically not altered by preservation in water-glass for a moderate period such as a year. Even when preserved for a much longer period the changes in composition which take place are very slight, and are not such as to render the eggs useless or objectionable as food.

My thanks are due to Mr. Clyne for the facilities he gave me for preserving experimental lots of eggs, and for supplying me with samples of ordinary commercial preserved eggs and with information on various practical points.

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 9

REPORT

ON THE

CAUSATION AND SPREAD OF ANTHRAX

1908

BY

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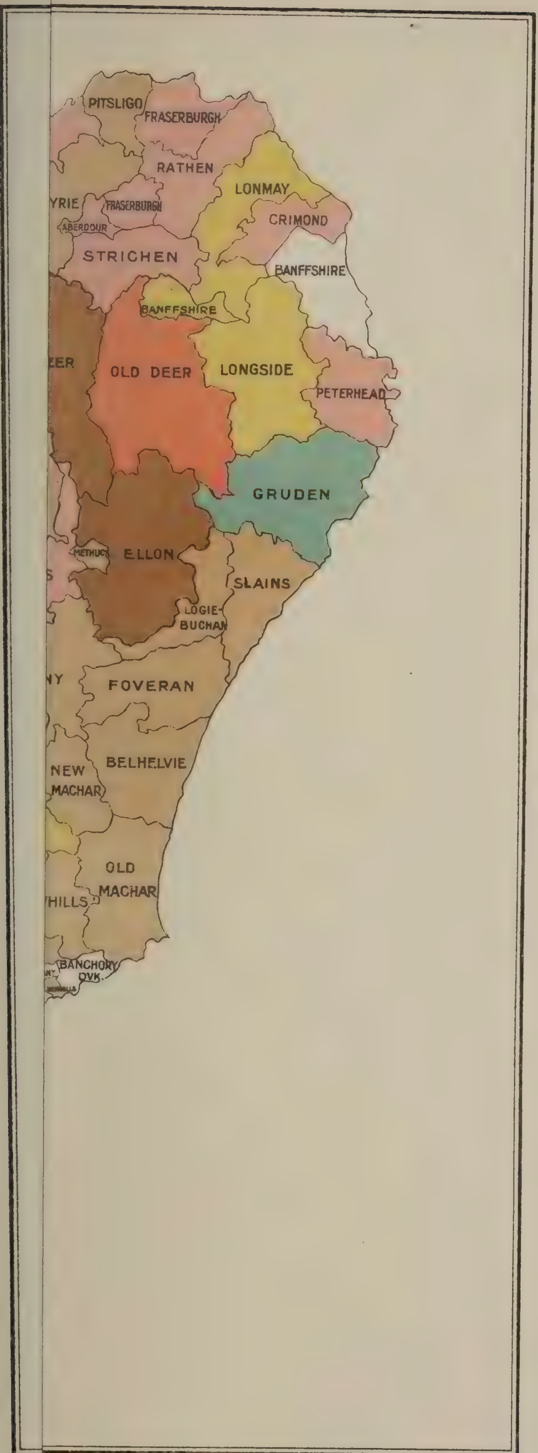
PITSLIGO
FRASERBURGH
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LONMAY
YRIE
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CRIMOND
ABERDOUR
STRICHEN
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ZER
OLD DEER
LONGSIDE
PETERHEAD
GRUDEN
METHLICK
ELLON
SLAINS
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FOVERAN
BELHELVIE
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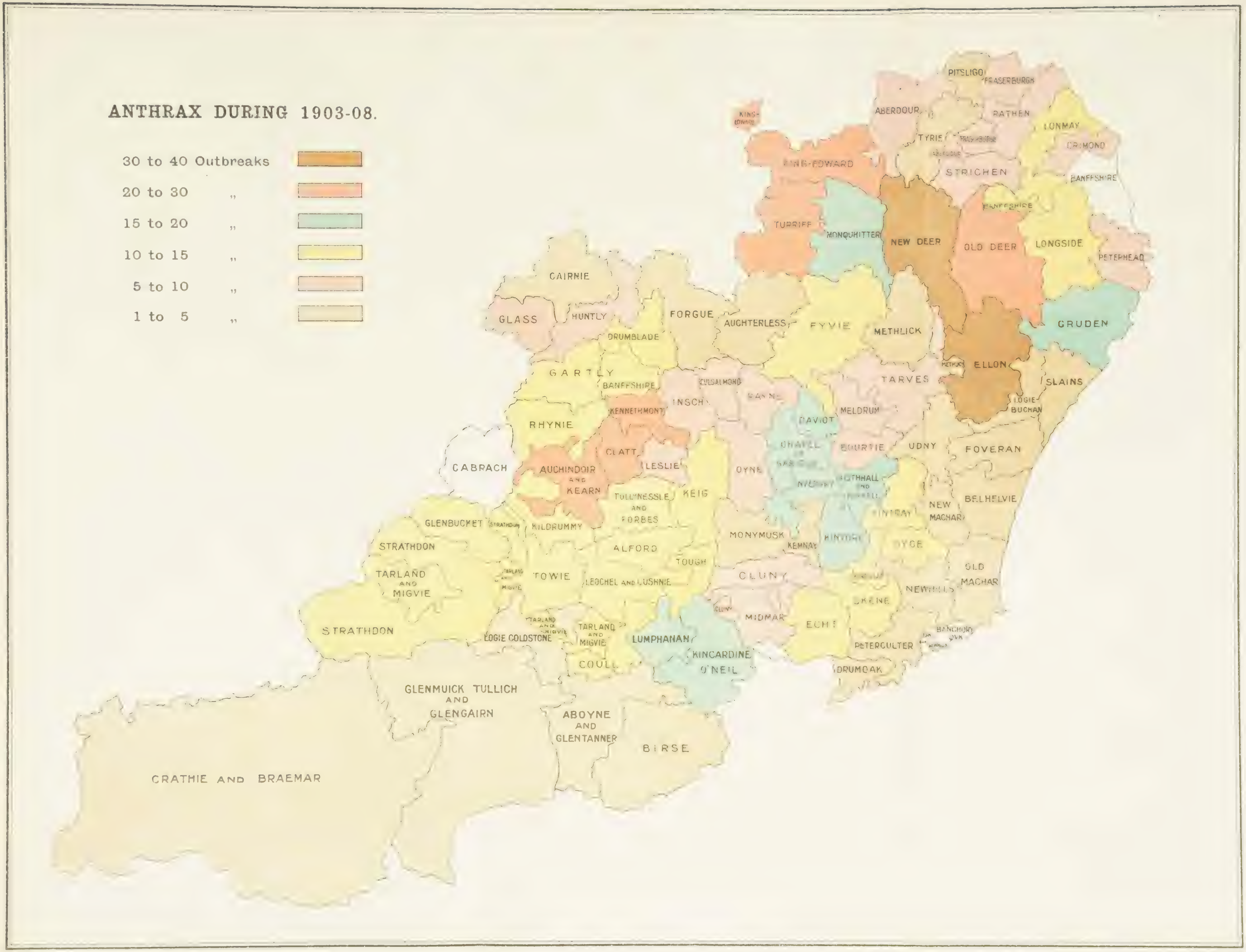

ANTHRAX DURING 1903-08.
30 to 40 Outbreaks
20 to 30 „
15 to 20 „
10 to 15 „
5 to 10 „
1 to 5 „
PITSLIGO
FRASERBURGH
ABERDOUR
RATHEN
LONMAY
TYRIE
CRIMOND
KING-EDWARD
STRICHEN
BANFFSHIRE
TURRIFF
MONQUHITTER
NEW DEER
OLD DEER
LONGSIDE
PETERHEAD
CAIRNIE
GLASS
HUNTLY
FORGUE
AUCHTERLESS
FYVIE
METHLICK
CRUDEN
DRUMBLADE
GARTLY
ELLON
TARVES
SLAINS
INSCH
CULSALMOND
KENNETHMONT
DAVIOT
MELDRUM
LOGIE-BUCHAN
RHYNIE
CHAPEL OF GARIOCH
BOURTIE
UDNY
FOVERAN
CABRACH
CLATT
LESLIE
AUCHINDOIR AND KEARN
OYNE
INVERURIE
KEITHHALL AND KINKELL
TULLYNESSLE AND FORBES
KEIG
FINTRAY
NEW MACHAR
BELHELVIE
GLENBUCKET
KILDRUMMY
MONYMUSK
KINTORE
KEMNAY
STRATHDON
ALFORD
DYCE
TARLAND AND MIGVIE
TOWIE
TOUGH
CLUNY
OLD MACHAR
LEOCHEL AND CUSHNIE
SKENE
NEWHILLS
MIDMAR
ECHT
LOGIE COLDSTONE
LUMPHANAN
KINCARDINE O'NEIL
PETERCULTER
BANCHORY
COULL
DRUMOAK
GLENMUICK TULLICH AND GLENGAIRN
ABOYNE AND GLENTANNER
BIRSE
CRATHIE AND BRAEMAR

THE CAUSATION AND SPREAD OF ANTHRAX.

THE extraordinary prevalence of anthrax in the County of Aberdeen suggested an inquiry into its causation and spread, and the information obtained during the past four years is now published in this report. In order to make this report as comprehensive and useful as possible, it may be of value to give a short description of the disease before proceeding to statistics.

Anthrax is classed as a rapidly fatal form of septicæmia or blood disease, or, in other words, it is due to a pathogenic or disease-producing organism having entered the blood stream. This organism is known as the Bacillus Anthracis, and without this organism no anthrax can exist. Anthrax has been ascribed to various foods and feeding stuffs, but it must be clearly understood that the food has simply acted as the vehicle by which the bacillus has been carried into the animal body. Inoculation might take place by some external wound, such as in the foot or body, but in the vast majority of cases the virus has been introduced by the alimentary track. It is more difficult to prove how the bacillus found its way into the food, but before entering on that question it may help us to notice some interesting and important facts concerning the organism itself.

The Bacillus Anthracis is a rod-shaped organism, with square-cut ends, and, although microscopic, is large when compared with many other pathogenic micro-organisms. As early as 1849 Pollender, and in 1856 Rayer and Davaine, demonstrated the bacillus in the blood of animals which had died from splenic apoplexy, and in 1857 Brauell found the same bacillus in the blood of a man. To-day we know, except under special circumstances, it is always to be found in the blood of an animal which has died

from anthrax, and it may also be present in the discharges from the mouth, nose and anus. It does not possess the power of movement, and multiplies by division, *i.e.*, each rod divides, and each division grows until it in turn divides. This process is quite different from the formation of spores which the Bacillus Anthracis rarely, if ever, does within the body. Spores are sometimes called eggs, but this is not strictly correct, as their formation is a resting stage in the history of the organism, and are only formed when the bacillus finds itself unable to live because of adverse conditions. Under such circumstances the bacilli form spores, much more tenacious of life, and which because of being enclosed in a thick membrane are able to stand heat, cold and comparatively strong disinfectants. Not only so, but under circumstances which would rapidly prove fatal to the bacilli, the spores remain viable for years, this being Nature's way of preventing the extinction of the organism. The bacilli are killed by two minutes' exposure to a 1 per cent. solution of carbolic acid in water, but the spores will remain alive for more than a week in a similar solution. Koch found they resisted boiling for five minutes, and dry heat to kill them must be applied for several hours at 140° Centigrade.

In a dry condition they possess their power of inducing disease for an indefinite period, while, unlike the bacillus, they can resist the action of gastric juice for many hours. A decomposing carcase admits of a condition favourable to the development of spores, as there is free access to the air, but during the putrefactive process the bacilli are killed, and in ten days or thereby very few remain. The spores are unaffected and may remain alive, though latent, for years, or they may germinate, multiply and grow on the organic matter present in the soil; but if the bacilli thus formed are swallowed they are killed by the gastric juice. But the spores may lie, as spores, in the ground until ingested by an animal, when they can pass uninjured through the stomach, and gaining an entrance into the intestine infect its wall and ultimately reach and multiply in the blood, causing death. Perhaps a more frequent mode of infection is through open wounds in the lips, gums or tongue, and this offers the explanation why so many oxen die of anthrax when rising two years of age. At this time they are casting the two middle incisors or

front teeth, and thus offering an easy access to the bacilli or spores. The bacilli, or more likely the spores, may be carried by any one of the many varieties of foods, and if the soil be infected roots bearing particles of soil will become a ready means of conveyance. During the summer grazing it is easy for the animal to have small wounds in the neighbourhood of the mouth from pieces of glass, broken jars, sharp stones or thorns. Foreign manures, especially bone, have been said to infect the soil, and, although this is a likely means, the evidence is not strong enough to warrant any interference with the trade. Two descriptions of bones are imported into this country, known to the trade as "Plano or Campo" and "Kitchen or Consumo". The first are bones picked up on grazing lands, and are mostly of animals which have died. The second are bones from meat extract factories, and in the preparation of the extract have been boiled and are thus less likely to convey pathogenic spores. As heating bones does not lessen their manurial value—in fact improves it—it might be well if all bones were subjected to such a temperature and for such a time as would destroy all possibility of conveying disease.

During the last three months of 1904 I carried out a long series of experiments with a sample of bones from a cargo just imported, but all the results were negative.

About the same time I visited a farm where anthrax kept occurring year after year, and on making inquiries I was directed to a field where a large number of animals had been buried during the past twenty years. I took samples of soil, at a depth of nine or ten inches, from several graves, and found one of the samples contained anthrax. This sample was taken from a grave at the upper part of a field where a yearling stirk, supposed to have died from quarter ill, had been buried. I also ascertained that this was the most recent burial on the farm. Another farm in the same district with a somewhat similar history was visited, and on inquiry the following interesting and suggestive facts were elicited :—

Three animals had died from anthrax. Two parts of a field —one at the side and the other a hollow near the centre—had for years been used as the burial-places for all animals dying on the farm. The drainage from both places runs into a small stream which formed the drinking water of the three dead

animals. For about ten days prior to their death the animals had been grazing in a field separated from the first burial-place by a very poor wire fence, and they were repeatedly seen eating the grass growing on the graves. Samples of soil were taken from both places, but cultivations and inoculations all proved negative.

In another case stable and byre manure, which we had reason to suspect had become infected by the blood of an animal which had died from anthrax, was innocently spread over a field. I took several samples of soil and manure from different parts of the field, and Professor Hamilton found anthrax in most of them. The following year another animal died from anthrax, and it was ascertained that it had been fed on tares grown on this particular field. In many other cases investigated on the same lines the results proved negative, but the history of the cases gave one the opinion had the proper sample been taken anthrax would have been found. How many cattle must have grazed or partaken of crops raised on that soil, yet they escaped, while the one, unfortunate enough to graze on the infected spot or to partake of the one quantity of infected food, paid forfeit with its life ?

On a farm in Aberdeenshire an animal died, in October, 1903, of anthrax, and was buried in a field which this year (1908) is in turnips. No case has occurred since until this year, when an animal fed on the turnips from that field died of anthrax. We cannot trace the actual connection, but it is suggestive.

It was said by Pasteur and confirmed by Bollinger that earth worms were agents in the spread of anthrax by bringing to the surface the spores. Koch denied this, but his explanation of the recrudescence of epidemics in fields where anthrax carcases had been buried is much less feasible than that advanced by Pasteur.

There seems little doubt but that the soil plays a considerable part in the cause and spread of the disease, and, as if by the irony of fate, cultivated ground is always richer in bacterial growth than virgin soil. While there is a difference in composition the cultivated soil has always greater opportunity of contamination, and certainly carries more stock. The carcases of animals *known* to have died from anthrax are carefully disposed of and the premises disinfected, but there are many animals which die, and anthrax not being suspected their carcases are improperly buried.

The possibility of sheep being factors in the dissemination was suggested to me by seeing a shepherd after skinning a fallen sheep drag the carcase along the ground for at least 100 yards, and finally throw it in a small stream. Had that sheep died of anthrax, the spot where it was skinned and the track along which it was drawn, to say nothing of the water in the lower part of the stream, must have been infected and likely to reproduce the disease. Not only so, but the skin was removed home, where it, in turn, had every opportunity of causing an outbreak, as preventive measures would be unthought of. The fact that the sheep is dead is sufficient for the shepherd, and he straightway proceeds to skin and dispose of the carcase in the most perfunctory manner without ever thinking of ascertaining the cause of death.

Veterinary surgeons are seldom called to sheep, and certainly rarely to dead ones, but it was with a view to elucidate, if possible, to what extent anthrax did exist in sheep that I sent the following circular to all veterinary surgeons in England, Scotland and Wales. For the reason already mentioned most of the replies were to the effect that the gentlemen had no experience; but the positive replies received, and now published, are sufficient to show, in my opinion, that anthrax exists in sheep to a greater extent than has hitherto been known. The following is the circular and questions asked, and the answers are given in order of questions 1, 2 and 3.

"MARISCHAL COLLEGE,
"ABERDEEN, *Nov.* 7, 1908.

"DEAR SIR,

"On behalf of the College I am conducting an inquiry into the spread of anthrax, and, as its occurrence in sheep has an important bearing on the infection of the soil, might I ask you to be good enough to assist me by answering the questions on other page, and returning same to me.

"Thanking you in anticipation,

"I am,

"Yours very truly,

"J. McLAUCHLAN YOUNG."

Have you any experience of anthrax in sheep? ....

Were the cases determined by microscopic examination? ....

Can you state number of cases? ....

(*Signature*) ....

....

ADAM SIEVWRIGHT, ESQ., TARLAND.

1. At one time a good deal, but not much recently. Flockmasters keep these cases concealed if possible.

2. Sometimes, but this was before the recent regulations came in force.

3. Not from memory, but some seasons cases are more numerous than others. That cases do occur is quite certain.

DAVID CONSTABLE, ESQ., INCHTURE.

1. Yes.
2. Yes.
3. Ten, all at one place.

ANDREW SPRUELL, ESQ., DUNDEE.

1. Some.
2. Yes.
3. From memory, about twelve outbreaks.

JOHN R. McCALL, ESQ., GLASGOW VETERINARY COLLEGE.

1. Not in sheep.

I have no doubt that many deaths in sheep are due to anthrax, although they are not reported.

THOMAS R. GILCHRIST, ESQ., TREVARNA, WISHAW.

1. Yes.
2. Yes.
3. Seven.

WILLIAM RUSSEL, ESQ., 4 SILVER STREET, DUNBAR.

1. Have frequently observed this disease.
2. No. No opportunity at the time.
3. One case in particular in which three or four swine died

from marked anthrax, after eating the internal organs of a sheep found dead.

JOHN J. BELL, ESQ., 11 LONSDALE STREET, CARLISLE.

1. Yes.

2. Yes.

3. Not more than a dozen throughout the whole of my experience; but owners of sheep rarely report sudden deaths amongst flocks in this country.

CHARLES BLACKHURST, ESQ., DOWNING, BROUGHTON, PRESTON.

1. Yes.

2. Yes.

3. A very great number.

GEORGE BRAID, ESQ., NETHER HOUSE, ALNWICK.

1. Yes.

2. Yes.

3. Ten animals last year on one farm; might be more as farmer was not likely to tell all, as he sells his stock in stores.[1]

W. E. LITT, ESQ., SHREWSBURY.

1. Yes.

2. Yes.

3. Thirty-seven cases reported; two only proved to be anthrax.

M. CROFTS, ESQ., 65 ST. GILES STREET, NORTHAMPTON.

1. Very little.

2. I can only remember one many years ago.

3. I feel confident that cases of anthrax do occur in sheep with some frequency, but the British farmer does not, as a rule, take the trouble to report them to the police. He skins the carcase and buries it, and sells the skins.

J. HENDERSON, ESQ., EASINGWOLD, YORKS.

1. Personally none, but have had several clients who have lost sheep suddenly, and from description of symptoms should say that they have been anthrax.

[1] Two cattle died previous year, were carelessly buried in fields where sheep were grazing.

J. W. H. Mashetir, Esq., Huttons Ambo, York.

1. No.

I have no doubt that there are many cases of anthrax, but we are never called in to sheep in this district, although a very heavy breeding district. The sheep are skinned—the skins sold and the carcases buried—and the result is an occasional anthrax case of the human being.

W. A. Clifford, Esq., Edgington, Haplicross, Sussex.

1. Yes.
2. Yes.
3. Between thirty and forty died in three outbreaks.

James Martin, Esq., Wellington, Shropshire.

1. Yes.
2. Yes.
3. Twenty in one outbreak.

Sheep were from soil infection.

T. Butcher, Esq., Cleobury Mortimer.

1. Very little, one only.
2. Yes.
3. Few sudden deaths in sheep are reported, the loss being set down to "strike" by their owners, which in most cases are "Black Quarter," though I am convinced that not a few are anthrax.

W. G. B. Dickinson, Esq., Boston, Lincs.

1. Yes.
2. Yes.
3. Five or six out of a flock of 200 were noticed ill, two died, and I found anthrax bacilli in spleen; the outbreak was attributed to Russian oil-cake, which was discontinued. The remaining three sheep were destroyed, and the other sheep were removed to another pasture. One particular symptom was present in all affected animals—swelling and drooping of the ears. This is the only outbreak I have known in this district. The remains of the five sheep were cremated. I have known sheep thrive on land where cattle and horses have died from anthrax periodically for thirty-five years.

HAROLD LEENEY, ESQ., ST. ALBANS, HOVE, SUSSEX.

1. Yes, much.
2. Only a few.
3. No, but they would amount to a great many in thirty years.

R. W. DAWTREY, ESQ., CHICHESTER.

1. Yes.
2. Yes.
3. Several.

C. C. CLARK, ESQ., HACKFORD, ATTLEBORO', NORFOLK.

1. Yes.
2. Yes. Spleens were sent to Professor McFadeyan.
3. Seventy to eighty sheep, I believe, died.

W. PENHALE, ESQ., HOLSWORTHY, NORTH DEVON.

1. Yes.
2. Yes.
3. Several, but under twenty.

W. PLOMLEYS, ESQ., THE WONDERS, PEASMARSH, SUSSEX.

1. Yes.
2. Yes.
3. Cannot numerate them, but several.

W. W. GOLDSMITH, ESQ., HITCHIN, HERTS.

1. One outbreak. Eight years since post-mortem made of two sheep.
2. No.
3. At least ten.

THOMAS EASTWOOD, ESQ., 134 WITTON STREET, NORTHWICH.

1. Yes.
2. Yes.
3. Five separate cases.

J. L. BARLING, ESQ., HEREFORD.

1. No.

Although no experience in this matter, I feel convinced that many deaths from anthrax in sheep occur annually in this district, and I have several times told the farmers so.

Kenneth Barker, Esq., Thornbury, Gloucestershire.

1. No. If a sheep dies suddenly and is fat, it is skinned and dressed, and probably sold, and the owner never troubles to see what it died of. The butcher's diagnosis is good enough for him, "the usual chill".

Thomas Hartfield, Esq., Reading.

1. Yes.
2. Yes, some.
3. Many. Kept no list.

Wm. Scott, Esq., Bridgwater.

1. Yes. Considerable.
2. Yes.
3. Several.

John W. Bate, Esq., Sutton Weaver, Warrington.

1. Yes.
2. Yes.
3. Farm No. 1 = 166. Farm No. 2 = 3. Farm No. 3 = 2.

Am of opinion that there are scores of sheep die in Cheshire from anthrax, but don't get reported. Farmers in some cases take off their skins and then bury them, others bury them whole.

George Upton, Esq., Epping, Essex.

1. Yes.
2. Yes.
3. Thirty to forty cases.

Herbert Bibbey, Esq., Swonlof, Cheshire.

1. Yes.
2. Yes, and culture tests.
3. Cannot record exact number of sheep, but I have had to deal with about twenty outbreaks in sheep alone, which have been serious losses, within the last two years.

Charles Roberts, Esq., Church Road, Tunbridge Wells.

1. Yes, about twelve months ago.
2. Yes, and confirmed by the Board of Agriculture.

3. One sheep—on a farm where the disease has been occurring in cattle for four or five years (isolated cases).

C. W. Page, Esq., The Green, Banbury, Oxon.

1. Yes (slight).
2. One.
3. Two.

A. R. Routledge, Esq., Karnak House, Louth.

1. No.

PS.—My experience is based, as doubtless you mean it to be, in reference to this district only. I have seen anthrax in sheep at Farningham, Kent, some nine years ago, demonstrated by microscopical examination. Cause — "Shoddy" used as manure on hop gardens, crop of rape subsequently grown; fatality amongst sheep great, but cannot state definitely.

Clement Dyson, Esq., York.

1. Yes.
2. Yes.
3. No. Great numbers, not in England.

T. M. Parker, Esq., Whitechurch, Salop.

1. Yes.
2. Yes.
3. Two.

A. H. Berry, Esq., Board of Agriculture.

1. Yes.
2. Yes.
3. Unable.

Wm. Ascott, Esq., Bideford.

1. No, except as below.
2. Those in the Ilfracombe outbreak, yes.
3. Six.

I assisted in an investigation into an outbreak of anthrax on a farm near Ilfracombe in March, 1895, where the total loss was sixty bullocks, six horses, nine sheep and one pig, but the sheep were manifestly infected by the slaughtering of the bullocks, private veterinary aid being sought. I frequently hear of a farmer

having lost three or four sheep under suspicious circumstances, but so far have never been able to verify a case of anthrax. Indeed it is very seldom one is asked to make a post-mortem exam. of a single carcase, and in the cases where several have died one has generally been able to find a cause other than anthrax.

WM. PENHALE, ESQ., CASTLE STREET, BARNSTAPLE.

1. Yes. Seven died on a farm where there was an outbreak of anthrax among cattle.

2. No, not in the case of the sheep.

3. Seven on the farm alluded to and three on another farm under similar circumstances. A bullock, having died from anthrax, was pulled over the pasture which was grazed by sheep; a few days after three sheep died.

CHARLES C. ABRAM, ESQ., THE TYTLING, WORCESTER.

1. Not in this country.
2. Yes (in India).
3. Two or three.

JOHN ROSE, ESQ., MUCH WENLOCK, SHROPSHIRE.

1. One case in 1906.
2. Yes.
3. One only was reported.

JUSTUS LITTLER, ESQ., OAKHAM, RUTLAND.

1. Yes.
2. No.
3. No.

THOMAS LUDLOW, ESQ., MANSFIELD, NOTTS.

1. Yes.
2. Yes.
3. One case, several sheep found dead, with marked clinical symptoms apart from microscopic examination, no more deaths in flock after first outbreak.

T. V. PETTIFER, ESQ., THE KNOLL, TETBURY, GLOUCESTERSHIRE

1. Only in one flock.
2. Yes, at R.V.C., London.
3. Forty to fifty died, as also bullocks, horses, cows and pigs.

Sidney Sturgess, Esq., Ashby-de-la-Zouch.

1. Yes.

2. In one case.

3. About five cases I can call to mind—in the last case there were four deaths, in the other cases only one death.

J. J. Burchnall, Esq., Loughborough.

1. Very little.

2. Do not remember.

3. I only remember one case where three or four sheep died following the application of bone manure to a grass field.

R. C. Robinson, Esq., 18 Aglionby Street, Carlisle.

1. Yes; produced by inoculation.

2. Yes.

3. Two cases, produced by injecting two healthy sheep with anthrax bacilli. These experiments were carried out by the late Professor Nocard whilst I was a student at the French Veterinary School, Alfort, Paris.

W. J. Mulvey, Esq., King's Road, Chelsea.

1. Yes; but not within the last twenty years.

Thomas Shepherd, Esq., Bootle, Liverpool.

1. Not of recent years.

2. No; but were attributed to being on pasture having been dressed with foreign bones.

3. Can call to mind about four cases.

W. L. Gascoyne, Esq., Alnwick House, Lutterworth.

1. Only slight.

2. Yes.

3. One during the past nine years (on a farm notorious for anthrax for many years).

F. A. Ball, Esq., Ormskirk, Lancashire.

1. Very little, practically no sheep in my district.

2. Microscopically, cultivation and inoculation.

3. One case of anthrax in the sheep during the last seven years.

R. Glover, Esq., 55 Romford Road, Stratford.

1. Very little.
2. No.
3. Not more than two or three.

R. S. Reynolds, Esq., Knotty Ash, near Liverpool.

1. Yes, a good many outbreaks, but it is forty years ago, in Nottinghamshire.

E. R. Smythe, Esq., Falmouth, Cornwall.

1. Only one in twenty years.
2. Yes.
3. This case occurred on a farm where there had been an outbreak among the cattle and swine.

Albert Wheatley, Esq., Reading.

1. One case.
2. Yes.

A. G. Elder, Esq., Church Street, Tewkesbury.

1. Yes.
2. Yes, by self and confirmed.
3. Three.

T. W. Day, Esq., Newmarket.

1. A great deal, but in Australia.
2. Often, but generally without.
3. Not precisely, but some hundreds.

W. D. Blair, Esq., Dunwood, Dumbarton.

1. Very little.
2. Some of them.
3. No.

H. C. Harrison, Esq., Bowden, Cheshire.

1. One case this year.
2. Yes.
3. One.

John Riddoch, Esq., 7 Glengyle Terrace, Edinburgh.

1. Yes.

2. Yes.

3. No. The cases I saw occurred about twenty years ago in the country.

K. P. Rankin, Esq., The University, Liverpool.

1. Very slight.

2. Yes.

3. No record kept.

John Hutton, Esq., Pringle Bank, Kelso.

1. Very little.

2. No.

3. One or two before the order came out.

Wm. M. Reid, Esq., Arbuthnott, Fordoun.

1. Yes.

2. No.

3. No. Cases over a number of years.

Hugh Farquhar, Esq., Riccarton, Kilmarnock.

1. Two or three sheep at Arness, Fenwick, where several cows died.

2. Cattle were, and found bacillus, but not the sheep.

3. No.

G. A. M. Harle, Esq., Coldstream.

1. I have had only one case in which three horses, a number of cattle, sheep and pigs died.

2. Microscopic examination was made in the case of the horses but not of the sheep.

T. A. Douglas, Esq., Portland Road, Kilmarnock.

1. Yes.

2. Yes, at London.

3. Five or six, confirmed as above, but over twenty in two years in our district.

GEO. H. NICHOLSON, ESQ., KIRKCUDBRIGHT.

1. Yes.
2. Yes.
3. Yes.

R. L. DAWSON, ESQ., RAYNE-BY-INSCH.

1. Yes, a little.
2. No.
3. No.

T. M. McCONNELL, ESQ., WIGTON.

1. Yes.
2. No.
3. Two.

J. BUXTON, ESQ., HIGHGATE, LONDON.

1. On one occasion only.
2. Yes.
3. Five sheep were affected.

T. J. CAMPBELL, ESQ., CASTLE DOUGLAS.

1. Yes.
2. Yes.
3. Two farms, about fifty deaths.

J. R. U. DEWAR, ESQ., ROYAL VETERINARY COLLEGE, EDINBURGH.

1. Yes.
2. Yes.
3. No.

W. L. MACKENZIE, ESQ., ANNAN.

1. Yes.
2. Yes.
3. Half-a-dozen.

P. MANUEL, ESQ., 1 SOUTH STREET, CREWE.

1. Not much.
2. Yes.
3. Two.

P. J. WELCH, ESQ., SAFFRON WALDEN, ESSEX.

1. Very little.
2. No.
3. About a dozen.

A. M. MUNRO, ESQ., 20 HEATHCOTE STREET, HULL.

1. Not in Great Britain.
2. A few.
3. No. Hundreds.

G. GARNETT, ESQ., HOVE, BRIGHTON.

1. A few cases in South Africa.
2. No.
3. No.

JOSEPH GODBER, ESQ., KING STREET, SOUTHWELL.

1. Yes.
2. Yes.
3. Six.

J. R. DYKES, ESQ., WELLINGBOROUGH.

1. Comparatively little, as I have not seen a case during the last twenty years.
2. No.
3. Only one.

R. RAWLINS, ESQ., HOLT HOUSE, CHESTERFIELD.

1. Yes (in moor sheep).
2. Yes.
3. Four.

R. H. OVER, ESQ., RUGBY.

1. Not much.
2. Yes.
3. One outbreak among small flock, about six died.

HARRY THACKERAY, ESQ., EASTGATE, STAFFORD.

1. Yes, one case.
2. Yes.
3. One.

J. W. Senior, Esq., Wem, Shropshire.

1. Yes.
2. Yes.
3. Five or six.

W. J. Moody, Esq., Oxford.

1. One case only.
2. Yes.
3. One sheep only out of a flock of forty.

W. H. Blackburn, Esq., Barnard Castle, Durham.

1. Yes.
2. Yes.
3. One.

R. Stevenson, Esq., Longton, Staffs.

1. Yes.
2. —
3. One isolated case.

F. L. Gooch, Esq., Stamford.

1. Yes.
2. Yes.
3. None except isolated for ten years, when I had an outbreak due to infection by killing a cow and allowing the blood to remain.

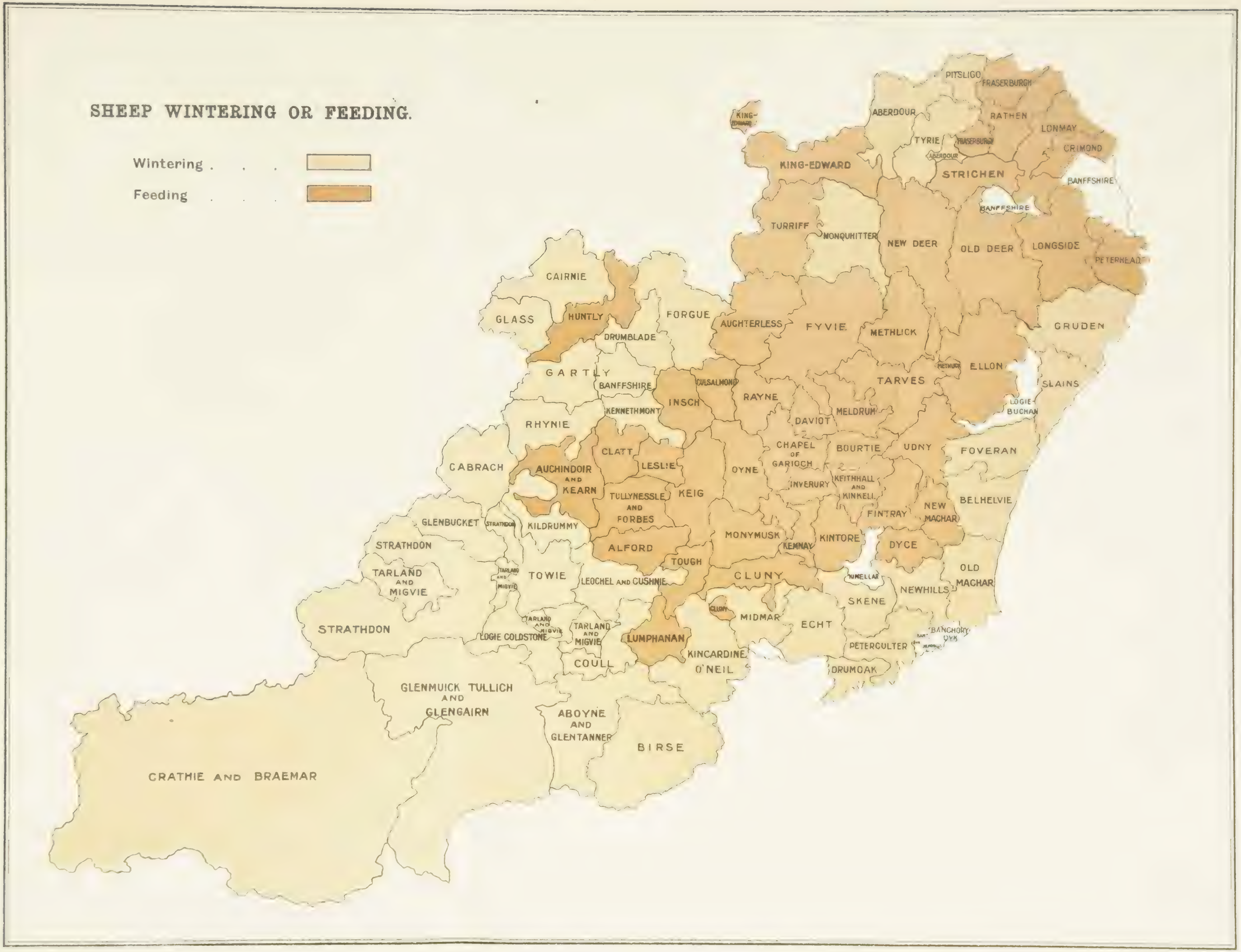
Wm. Caudwell, Esq., Chertsey.

1. Yes, one outbreak only, about 1886.
2. Yes.
3. Several sheep in a flock died. The shepherd stuck a bullock which was on the point of dying with anthrax, and he infected the pasture, where the sheep were grazing, with blood on his boots.

J. C. Jones, Esq., Newcastle Emlyn, S. Wales.

1. Yes.
2. No, most of them by post-mortem.
3. Fifteen to twenty from 1899-1905 in one parish in Carmarthenshire.


PITSLIGO
FRASERBURGH
RATHEN
LONMAY
TYRIE
FRASERBURGH
ABERDOUR
CRIMOND
STRICHEN
BANFFSHIRE
BANFFSHIRE
OLD DEER
LONGSIDE
PETERHEAD
GRUDEN
ELLON
SLAINS
LOGIE-
BUCHAN
UDNY
FOVERAN
BELHELVIE
NEW
MACHAR
OLD
MACHAR
NEWHILLS
BANCHORY
DYK.


SHEEP WINTERING OR FEEDING.
Wintering
Feeding
PITSLIGO
FRASERBURGH
ABERDOUR
RATHEN
LONMAY
CRIMOND
TYRIE
STRICHEN
KING-EDWARD
BANFFSHIRE
TURRIFF
MONQUHITTER
NEW DEER
OLD DEER
LONGSIDE
PETERHEAD
CAIRNIE
HUNTLY
FORGUE
GLASS
DRUMBLADE
AUCHTERLESS
FYVIE
METHLICK
GRUDEN
ELLON
GARTLY
CULSALMOND
TARVES
SLAINS
INSCH
RAYNE
KENNETHMONT
DAVIOT
MELDRUM
LOGIE-BUCHAN
RHYNIE
CHAPEL OF GARIOCH
BOURTIE
UDNY
FOVERAN
CABRACH
CLATT
LESLIE
AUCHINDOIR AND KEARN
OYNE
INVERURY
KEITHHALL AND KINKELL
TULLYNESSLE AND FORBES
KEIG
BELHELVIE
FINTRAY
NEW MACHAR
GLENBUCKET
STRATHDON
KILDRUMMY
MONYMUSK
KEMNAY
KINTORE
DYCE
ALFORD
TOUGH
OLD MACHAR
TARLAND AND MIGVIE
TOWIE
LEOCHEL AND CUSHNIE
CLUNY
KINELLAR
NEWHILLS
SKENE
MIDMAR
ECHT
LOGIE COLDSTONE
LUMPHANAN
KINCARDINE O'NEIL
PETERCULTER
BANCHORY DYK
COULL
DRUMOAK
GLENMUICK TULLICH AND GLENGAIRN
ABOYNE AND GLENTANNER
BIRSE
CRATHIE AND BRAEMAR

R. J. Hicks, Esq., Market Weighton, East Yorks.

1. Yes.

2. Yes, except cases in swine following ingestion of some part of diseased sheep.

3. Not definitely, upwards of twenty outbreaks; in one of them thirteen sheep died of anthrax.

J. R. Simpson, Esq., Ripon, York.

1. Only one outbreak.

2. Yes.

3. Cannot from memory.

J. F. Rees, Esq., Carmarthen.

1. Yes.

2. Yes.

3. Roughly about a dozen in the last fifteen years.

H. Southall, Esq., Driffield, E. Yorks.

1. Yes.

2. Yes.

3. Many cases.

J. C. Smith, Esq., 10 Windsor Terrace, Whitley.

1. Yes.

2. Yes.

3. One in the end of 1907.

A. Levie, Esq., 109 Herbert Road, Nottingham.

1. Yes.

2. No.

3. No. Large number.

W. T. D. Broad, Esq., Marlborough, Wiltshire.

1. Only a little.

2. Yes.

3. No.

G. H. Williams, Esq., Chippenham, Wilts.

1. Yes.

2. Yes.

3. Twice. First details not remembered; second, Two sheep about a week after a cow in same field—still have slide.

T. W. W. Hindle, Esq., Malmesbury, Wiltshire.

1. Yes.
2. Yes.
3. One.

A. Renfrew, Esq., Broadrig, Worcestershire.

1. Yes.
2. Yes.
3. No, but I have had many in the last ten or twelve years.

W. A. Campbell, Esq., Boroughbridge, Yorks.

1. Yes.
2. Yes.
3. Fifty-four in one lot and twelve in another, and several isolated cases.

Walter Edmondson, Esq., Harrogate.

1. Yes.
2. Most of them.
3. About forty cows (all one outbreak).

F. W. Garnett, Esq., Dalegarth, Windermere.

1. Only one case.
2. Yes.
3. One.

E. H. Pratt, Esq., Northallerton.

1. Yes, one case.
2. Yes.
3. One. This case followed the opening of an anthrax carcase of a beast in a pasture by an unqualified man.

J. S. Walker, Esq., Kirkby Lonsdale, Westmoreland.

1. One case.
2. Yes.
3. Two ewes and three lambs belonging to same farm all died in the same field on the same day (bones previously sown), one

cow ill died same day, two cows died after a few days, all anthrax, other cattle and a young horse had died before this, no doubt from anthrax; not determined by microscopic examination.

J. Magurie, Esq., Liverpool.

1. Yes.
2. Yes.
3. About twenty.

John Barker, Esq., Nelson, Lancashire.

1. Seen scores of cases previous to my professional career which I should now think were anthrax.
2. No. Scarcely ever called to sheep.
3. No.

James Laithwood, Esq., Alcumlow Hale Farm.

1. Yes.
2. Yes.
3. Ninety-five on one farm and two others.

J. C. Coleman, Esq., Swindon, Wiltshire.

1. Very little, but I have good reason to believe that many cases frequently occur in sheep and cattle and are never reported.
2. In one case only.
3. I have seen two cases in sheep.

W. B. Welden, Esq., Exeter, Devon.

1. We have scarcely any anthrax in sheep in Devon.

Henry Walpole, Esq., Whixley, York.

1. There was an outbreak of anthrax not far from me and several sheep died, but I had nothing to do with it. Several of the sheep died after the first inoculation with Pasteur's Anthrax Vaccine. No sheep died until the owner had lost horses and cattle from anthrax.

C. J. Humphrey, Esq., London.

1. Yes.
2. Usually not.
3. No.

T. W. Buecher, Esq., Hampton Manor, Evesham.

1. Yes.
2. Yes.
3. Five.

F. V. Steward, Esq., Gwynne House, Hereford.

1. No, but I believe it to be quite common or more so than in other animals.

R. M. Malloch, Esq., Appleby, Westmoreland.

1. No.

Think it (anthrax) more plentiful in sheep than suspected. Seen some very suspicious cases.

J. M. Stirling, Esq., 51 Ainsworth Street, Blackburn.

ANTHRAX IN SHEEP.

Year.	Date.	No of Cases.	Animal or Carcase, and where from.
1903	July 30	1	A ewe found dead in the sheep pens at the Abbatoir.
1904	June 20	2	A sheep found dying in the sheep pen, No. 6, Abbatoir.
1904	Oct. 3	3	A sheep brought dead from Witton.
1904	Oct. 6	4	A sheep found dying in the sheep pen, No. 12, Abbatoir.
1904	Dec. 28	5	A sheep brought dead from Livesey.
1905	March 1[illegible]	6	A sheep brought alive from Cumberland to Blackburn.
1905	Dec. 8	7	A sheep brought alive from Cockerham to Blackburn.
1906	March 8	8	A sheep brought alive from Glasgow, which died in a railway waggon during transit.
1906	Nov. 27	9	A sheep found dead in a field in Blackburn.
1906	Dec. 31	10	A sheep brought dead from Clayton-le-Moors.
1907	March 19	11	A sheep found dead in a field.
1907	July 15	12	A sheep found dead in a field.
1907	Aug. 13	13 and 14	Two sheep from Ireland, one dead and one dying.
1907	Sept. 25	15	A sheep found dying in a field.
1907	Nov. 4	16	A sheep which died suddenly in No. 2 sheep pen at the Abbatoir.

A careful microscopical examination of blood was made in every instance, and no doubtful case notified.

From these replies it would seem that the members of the veterinary profession are of opinion that anthrax exists to a

greater extent in sheep than would appear from the number of cases reported to the Board of Agriculture. During the past five years the official figures are:—

Year.	Outbreaks.	Cattle.	Sheep.	Swine.	Horses.
1903	767	809	48	234	51
1904	1,049	1,115	62	365	47
1905	970	1,001	53	210	53
1906	939	999	83	213	35
1907	1,084	1,163	66	190	37

These figures are for Great Britain, and for the counties embraced in our College area the figures for the same period are:—

1903.

County.	Outbreaks.	Cattle.	Sheep.	Swine.	Horses.
Aberdeen	82	89	—	—	4
Banff	13	17	—	—	—
Elgin	12	12	—	—	—
Kincardine	8	9	—	—	—
Inverness	—	—	—	—	—
Nairn	1	1	—	—	—
Ross and Cromarty	7	6	—	—	2
1904.					
Aberdeen	111	131	1	—	2
Banff	34	37	—	—	—
Elgin	16	20	—	—	—
Kincardine	16	20	—	—	2
Inverness	1	1	—	—	—
Nairn	—	—	—	—	—
Ross and Cromarty	2	2	—	—	—

1905.

County.	Outbreaks.	Cattle.	Sheep.	Swine.	Horses.
Aberdeen	100	113	2	—	—
Banff	11	14	—	—	—
Elgin	9	10	—	—	—
Kincardine	14	14	—	—	—
Inverness	1	1	—	—	—
Nairn	—	—	—	—	—
Ross and Cromarty . .	4	4	—	—	—
1906.					
Aberdeen	114	133	—	1	1
Banff	25	27	—	—	—
Elgin	11	13	—	—	—
Kincardine	10	10	—	—	1
Inverness	3	3	—	—	—
Nairn	2	2	—	—	—
Ross and Cromarty . .	2	2	—	—	—
1907.					
Aberdeen	93	103	—	—	2
Banff	33	35	—	1	—
Elgin	14	14	—	—	—
Kincardine	10	10	—	—	—
Inverness	4	5	—	—	—
Nairn	2	6	—	—	—
Ross and Cromarty . .	2	2	—	—	—

The estimated number of animals kept in the counties for the same period is as follows:—

Number of Cattle, Sheep, Swine, Horses, 1903.

1903.

County.	Cattle.	Sheep.	Swine.	Horses.
Aberdeen	179,672	208,742	11,905	—
Banff	44,611	60,623	3,024	—
Elgin	23,951	55,401	2,932	—
Kincardine	26,423	40,153	2,676	—
Inverness	51,722	569,181	2,489	—
Nairn	5,886	16,861	757	—
Ross and Cromarty	45,606	268,948	4,910	—
1904.				
Aberdeen	171,815	204,136	13,509	31,725
Banff	44,417	59,927	3,252	9,258
Elgin	24,215	55,756	3,229	5,087
Kincardine	24,377	39,949	2,924	5,115
Inverness	51,624	544,809	2,517	9,438
Nairn	6,392	15,554	735	1,509
Ross and Cromarty	45,060	262,313	5,059	7,932
1905.				
Aberdeen	167,696	202,823	12,142	31,966
Banff	43,031	61,707	3,253	9,182
Elgin	23,197	53,832	2,606	5,153
Kincardine	25,431	45,025	2,554	5,042
Inverness	50,080	537,632	2,350	9,524
Nairn	6,219	18,518	616	1,482
Ross and Cromarty	45,002	264,897	4,290	7,979

1906.

County.	Cattle.	Sheep.	Swine.	Horses.
Aberdeen	168,883	212,904	12,347	31,835
Banff	42,832	61,969	3,274	9,130
Elgin	21,986	56,054	2,681	5,080
Kincardine	24,574	45,369	2,673	5,045
Inverness	49,775	532,880	2,323	9,627
Nairn	6,171	18,877	589	1,436
Ross and Cromarty . .	43,447	262,002	4,029	8,177
1907.				
Aberdeen	167,018	245,866	14,243	31,570
Banff	44,141	65,402	4,001	9,259
Elgin	22,435	59,560	2,922	4,883
Kincardine	23,835	52,185	3,142	5,016
Inverness	50,105	554,358	2,674	9,572
Nairn	5,979	18,951	776	1,424
Ross and Cromarty . .	43,272	279,047	4,508	8,184

In the County of Aberdeen where anthrax is more prevalent than in any other county its occurrence is interesting, especially when we compare its prevalence with the number of sheep wintered or fed in certain districts. During the last five years outbreaks have been reported in the various parishes as follows :—

Anthrax, 1903-8.

	Parish.	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.	Total.
1	Aberdour	3	3	1	1	—	8
2	Tyrie	2	1	—	—	—	3
3	Pitsligo	—	—	—	2	—	2
4	Rathen	3	1	1	2	3	10
5	Strichen	5	1	2	—	1	9
6	Lonmay	1	4	1	3	3	12
7	Crimond and St. Fergus	3	4	—	1	2	10
8	Peterhead	4	2	1	—	1	8
9	Longside	5	2	1	3	1	12
10	Old Deer	6	11	8	2	1	28
11	New Deer	9	1	14	5	10	39
12	Fraserburgh	—	—	—	3	4	7
13	Methlick	1	1	—	3	—	5
14	Tarves	1	—	1	2	3	7
15	Udny	1	—	1	—	2	4
16	Ellon	7	11	6	5	4	33
17	Cruden	7	6	2	2	—	17
18	Slains and Logie-Buchan	2	—	2	—	—	4
19	Foveran	1	—	—	—	—	1
20	Insch, Leslie and Premnay	2	3	1	—	—	6
21	Culsalmond, Rayne and Oyne	4	1	—	1	—	6
22	Chapel of Garioch and Daviot	7	2	2	1	4	16
23	Bourtie and Meldrum	2	—	1	3	2	8
24	Inverurie, Keith-Hall and Kintore	3	5	4	2	5	19
25	Kemnay and Monymusk	—	1	1	1	1	4
26	Crathie	—	—	1	1	—	2
27	Glenmuick	—	2	1	2	—	5
28	Aboyne and Birse	—	1	—	—	1	2
29	Cromar (Tarland)	1	2	2	4	5	14
30	Kincardine O'Neil and Lumphanan	4	4	3	4	4	19
31	Cluny and Midmar	1	1	5	1	2	10
32	King Edward	5	6	6	8	2	27
33	Monquhitter	3	5	5	3	—	16
34	Fyvie	3	3	—	4	2	12
35	Auchterless	4	—	—	—	1	5
36	Turriff	3	4	5	8	6	26
37	Belhelvie	1	1	—	1	—	3
38	Newmachar	2	—	2	—	1	5
39	Dyce, Fintray and Kinellar	4	3	1	3	2	13
40	Old Machar	—	—	1	—	—	1
41	Newhills	—	—	—	3	—	3
42	Echt and Skene	2	2	7	1	1	13
43	Cults	—	—	—	—	—	—
44	Drumoak and Peterculter	—	1	—	1	3	5
45	Alford, Kildrummy and Tullynessle	2	3	4	4	1	14
46	Leochel-Cushnie, Tough and Keig	2	2	7	—	—	11
47	Auchindoir, Clatt and Kennethmont	6	7	10	3	4	30
48	Glenbuchat, Strathdon and Towie	—	2	3	3	3	11
49	Cairnie, Glass and Huntly	2	2	—	2	3	9
50	Drumblade, Gartly and Rhynie	1	3	1	6	2	13
51	Logie-Coldstone	2	—	1	—	—	3
52	Cairney	—	3	—	—	—	3
53	Forgue	1	—	—	1	2	4

It is impossible to obtain reliable information as to the number of sheep in each parish, but the returns under the Dipping Act for the police districts will give a fair indication. It will be noticed that the total number of sheep in the county, as shown by the dipping returns, is considerably higher than the Government estimate, but this is explained by the fact that the dipping enumeration is taken at a time when an abnormal number of sheep from the highlands are in the county for wintering. Since the Act came into force the returns are as follows:—

COUNTY OF ABERDEEN.

Number of Sheep in the County during the Year 1905, as shown by the Returns under the Sheep Dipping (Scotland) Order of 1905:—

Police Districts.	Number of Sheep.
Aberdeen Division—	
Cults	785
Culter	940
Echt	999
Skene	301
Blackburn	799
Bucksburn	304
Dyce	1,456
Newmachar	2,108
Udny	521
Tarves	3,586
Ellon	4,270
Hatton of Cruden	620
Newburgh	5,389
Balmedie	2,508
Bridge of Don	695
Peterhead Division—	
Boddam	999
Port Erroll	1,090
Stuartfield	9,488
Longside	3,325
St. Fergus	6,853
Fraserburgh Division—	
Cairnbulg	5,906
Rosehearty	2,086
New Aberdour	3,636

Police Districts.	Number of Sheep.
Fraserburgh Division (cont.)—	
New Pitsligo	89
Strichen	1,002
Maud	2,439
New Deer	2,765
Inverurie Division—	
Kintore	720
Inverurie	3,679
Pitcaple	923
Oldmeldrum	1,692
Methlick	7,712
Fyvie	6,210
Auchterless	2,585
Turriff	1,188
Cuminestown	1,178
New Byth	278
Huntly Division—	
Insch	3,955
Kennethmont	2,851
Rhynie	6,766
Huntly	15,121
Glass	4,620
Forgue	2,823
Alford Division—	
Kemnay	460
Cluny	4,718
Monymusk	303
Alford	7,570
Lumsden	4,332
Strathdon	9,020
Corgarff	11,580
Aboyne Division—	
Torphins	1,883
Lumphanan	4,272
Kincardine O'Neil	3,357
Tarland	2,069
Aboyne	4,930
Ballater	15,917
Braemar	8,036
Total	205,708

Sheep Dipped within the County during the Period from 1st September to 12th November, 1906, under the Sheep Dipping (Scotland) Order, 1906 :—

Police Districts.	Number of Sheep.
Aberdeen Division—	
Cults	113
Culter	2,221
Echt	3,634
Skene	736
Kingswells	57
Bucksburn	1,187
Blackburn	1,954
Dyce	2,976
Newmachar	4,426
Udny	629
Tarves	4,184
Methlick	4,622
Ellon	6,505
Newburgh	4,0[illegible]6
Hatton of Cruden	1,665
Balmedie	4,571
Bridge of Don	511
Peterhead Division—	
St. Fergus	4,237
Stuartfield	8,166
Longside	3,517
Port Erroll	2,761
Boddam	292
Fraserburgh Division—	
New Deer	5,064
Maud	1,916
Crimond	2,027
Cairnbulg	2,914
Rosehearty	4,237
New Aberdour	2,712
New Pitsligo	4,387
Inverurie Division—	
Inverurie	7,653
Kintore	2,997
Oldmeldrum	3,587
Pitcaple	3,774
Fyvie	7,569

Police Districts.	Number of Sheep.
Inverurie Division (cont.)—	
Cuminestown	1,050
Auchterless	4,467
New Byth	2,081
Huntly Division—	
Kennethmont	3,855
Insch	6,952
Forgue	3,141
Rhynie	5,700
Glass	3,497
Huntly	13,154
Alford Division—	
Kemnay	2,983
Monymusk	1,919
Cluny	2,586
Corgarff	4,191
Strathdon	5,715
Lumsden	4,070
Alford	7,880
Aboyne Division—	
Braemar	3,879
Ballater	11,655
Tarland	3,071
Aboyne	3,840
Kincardine O'Neil	3,332
Lumphanan	5,133
Torphins	2,015
Total	226,626

Number of Sheep Dipped within the County during the Period from 1st September to 12th November, 1907, under the Sheep Dipping (Scotland and North of England) Order of 1907 :—

Police Districts.	Number of Sheep.
Aberdeen Division—	
Cults	606
Culter	3,149
Echt	3,267
Skene	1,260

Police Districts.	Number of Sheep.
Aberdeen Division (cont.)—	
Kingswells	1,089
Bucksburn	1,484
Blackburn	2,452
Dyce	2,443
Newmachar	4,460
Udny	680
Tarves	4,449
Methlick	4,637
Ellon	6,047
Newburgh	4,876
Hatton	1,756
Balmedie	4,476
Bridge of Don	909
Peterhead Division—	
St. Fergus	5,320
Stuartfield	8,837
Longside	3,132
Port Erroll	2,197
Boddam	470
Fraserburgh Division—	
New Deer	3,922
Maud	2,802
Strichen	1,605
Cairnbulg	2,238
Rosehearty	3,884
Aberdour	4,134
New Pitsligo	4,539
Crimond	3,168
Inverurie Division—	
Inverurie	5,098
Kintore	5,314
Oldmeldrum	3,380
Pitcaple	3,103
Fyvie	7,699
Cuminestown	2,995
Auchterless	4,502
Turriff	9,006
New Byth	1,584
Huntly Division—	
Kennethmont	3,859
Insch	9,242

Police Districts.	Number of Sheep.
Huntly Division (cont.)—	
Forgue	2,809
Rhynie	5,796
Glass	3,483
Huntly	13,021
Alford Division—	
Kemnay	1,427
Monymusk	1,771
Cluny	2,227
Corgarff	2,943
Strathdon	7,174
Lumsden	4,352
Alford	7,923
Aboyne Division—	
Braemar	2,738
Ballater	12,085
Tarland	3,149
Aboyne	3,856
Kincardine O'Neil	3,730
Lumphanan	4,865
Torphins	4,162
Total	237,584

Most of these sheep are being wintered in the county, but a very considerable portion are fed on turnips and artificial foods for the fat market, and it is interesting to note that there seems to be some connection between this feeding and the prevalence of anthrax. An endeavour was made to ascertain the management of sheep in the various districts, and it is most suggestive to find that in certain districts where the disease is more prevalent it is the custom to feed the sheep for the butcher instead of wintering them for return to their native hills. If the following table be compared with that showing the outbreaks in the parishes this interesting and suggestive fact will be observed.

Police Districts.	
Aberdeen Division—	
Cults	Wintering.
Culter	"

Police Districts.	
Aberdeen Division (cont.) —	
Echt	Wintering.
Skene	,,
Kingswells	,,
Bucksburn	,,
Blackburn	Feeding.
Dyce	,,
Newmachar	,,
Udny	,,
Tarves	,,
Methlick	,,
Ellon	,,
Newburgh	Wintering.
Hatton	Feeding.
Balmedie	Wintering.
Bridge of Don	,,
Peterhead Division—	
St. Fergus	Feeding.
Stuartfield	,,
Longside	,,
Port Erroll	,,
Boddam	Wintering.
Fraserburgh Division—	
New Deer	Feeding.
Maud	,,
Strichen	,,
Cairnbulg	,,
Rosehearty	Wintering.
Aberdour	,,
New Pitsligo	,,
Crimond	Feeding.
Inverurie Division—	
Inverurie	Feeding.
Kintore	,,
Oldmeldrum	,,
Pitcaple	,,
Fyvie	,,
Cuminestown	Wintering.
Auchterless	Feeding.
Turriff	,,
New Byth	Wintering.

Police Districts.	
Huntly Division—	
Kennethmont	Wintering.
Insch	Feed·ng.
Forgue	Wintering.
Rhynie	,,
Glass	,,
Huntly	Feeding.
Alford Division—	
Kemnay	Feeding.
Monymusk	,,
Cluny	,,
Alford	,,
Corgarff	Wintering.
Strathdon	,,
Lumsden	,,
Aboyne Division—	
Lumphanan	Feeding.
Braemar	Wintering.
Ballater	,,
Tarland	,,
Aboyne	,,
Kincardine O'Neil	,,
Torphins	,,

One cannot be but struck by the similarity of the maps showing the prevalence of the disease and where sheep are being fed. There must be some reason for this, and it may be because more artificial foods are being used, but if that were so we should have anthrax recurring on the same farms, as it is most unlikely that the farmer will change yearly the system of feeding. Again, notwithstanding the volume of evidence that anthrax exists to a considerable extent in sheep, during the last five years there have been reported in our College area 765 outbreaks of anthrax involving the death of 866 cattle, yet only 3 sheep have been reported—1 in 1904 and 2 in 1905. In 1906 of the 936 outbreaks in Great Britain, 114 were in Aberdeenshire, resulting in the death of 133 cattle, and although during that year 83 sheep were reported as having died from anthrax not one came from Aberdeenshire. To those who have studied the question it is a well-known fact that anthrax occurs most commonly on farms where it had not been previously known or at least not for some

time, and the outbreak results in the death of but one or two animals. The Board of Agriculture considers a "clean farm" one from which no case of anthrax has been reported for five years, and further inquiry failed to produce evidence that unreported cases might have occurred. Farmers and shepherds do not believe that anthrax occurs in sheep, and the various deaths in the flocks are never taken into account when inquiry is being made concerning previous outbreaks. When the disease occurs in cattle or horses it is generally discovered and precautions taken to dispose of the carcase without unduly spilling blood and discharges. Disinfectants are used and every endeavour made to destroy the virus, but anthrax is seldom discovered in sheep—in fact, is seldom looked for—and the carcase is skinned and improperly disposed of. The skin is taken home to dry and is frequently to be found hanging on the rafters of the turnip-shed or in the proximity of food, where, when a sufficient number has collected, it is thrown to the ground and freely shaken. If the sheep should have died of anthrax the disturbed spores may easily fall on to the food, and under such circumstances it is not difficult to understand the death from anthrax of a feeding ox in the byre. Now the farm having lost its "clean" character is under suspicion and care is exercised, with the not unexpected result that no further outbreak occurs for some time.

The amount of proof that this is a source of infection is meagre, but circumstantial evidence is strong, and I cannot but suggest that sheep play a considerable part in the dissemination of anthrax. If this is so it is not difficult to prove, and I venture the opinion it is well worth investigating. A living animal suffering from disease is always a source of danger, but surely when death takes place, measures based upon scientific knowledge and sanitary principles could be adopted for the disposal of the carcase, so that the danger would be exterminated and all possibility of future infection removed.

I would recommend that local authorities frame some regulations for the examination by the district Veterinary Inspector of the carcases of feeding sheep dying suddenly, and if anthrax is found the same procedure to be observed as in cattle. No such regulations would, in the meantime, be necessary for hill or wintering sheep, but the shepherd might be instructed to dispose of the

carcase by burial and if possible lime. If a carcase is skinned the storage of the skin is to be considered, and it must not be brought in contact nor in the neighbourhood of feeding stuffs. The carcase is not to be skinned on the pasture but removed to a spot where it can be buried, and any earth which becomes soiled during the skinning can be thrown into the grave. Such regulations concerning feeding sheep to remain in force sufficiently long to allow of proof whether sheep are or are not, in this way, factors in the spread of anthrax.

Concerning other farm animals—cattle, horses and pigs—there is abundant evidence to prove that, unless proper precautions are taken, they are sources of danger owing to the contaminating influences of the discharges. The stock-owner's first duty is to himself and his own stock, but he certainly has a duty to his neighbours, and to ensure that every animal likely to disseminate anthrax is disposed of in a way calculated to remove the danger it would be well to introduce a system of compulsory notification of the sudden deaths occurring in all farm animals. This, with the exception of sheep, means little more than at present, and it appears necessary, as it would prevent the removal of an anthrax carcase from the farm to the slaughter-house or the manure works, and ensure that it was properly disposed of under expert supervision.

From the results of my inquiry I draw the following conclusions :—

I. Anthrax occurs more frequently in sheep than is generally known.

II. That it is more likely to appear in feeding than hill or wintering sheep.

III. That there are many opportunities by which it may be spread by sheep to other farm animals.

IV. That there is abundant evidence it is spread to other animals by cattle, horses and pigs.

V. That it would be advisable to frame some regulations for the examination and proper disposal of the carcases of feeding sheep dying suddenly.

VI. That shepherds on high as well as lowland pastures should adopt a better method of disposing of carcases.

VII. That there should be compulsory notification of all sudden deaths in farm stock.

J. McLAUCHLAN YOUNG,
F.R.C.V.S., F.R.S.E., F.Z.S.

June, 1908.

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 10

REPORT

1.

ON TURNIP EXPERIMENT

1907

2.

ON ROTATION EXPERIMENT AT MIDTOWN, CORNHILL

BY

R. B. GREIG, F.H.A.S., F.R.S.E.

ABERDEEN: THE UNIVERSITY PRESS
1909

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Thanks are due to the occupants of the farms named in the Report, who gave facilities for the experiments and who incurred much trouble in their supervision and execution.

REPORT ON TURNIP MANURING EXPERIMENTS AND ROTATION EXPERIMENTS, 1907.

THE first part of this report deals with the Turnip Manuring Experiments undertaken by the College at sixteen centres in 1907, but returns from four of those centres are not included in the general averages. At Mill of Forest and Nether Benholm the wet weather of May affected several plots unequally; at Aldourie the soil at one end of the experimental area differed from the rest of the field; and at Balmachree, "finger and toe" completely masked the effects of the manures.

The year was unfavourable to field trials of any crop, but the experimental areas suffered less as a rule from "shooting" or "bolting" than the general crop of the North. The returns from the unmanured plot for each year since 1903 are as follows, and judging from them, 1907 was the worst turnip year of the last four:—

Year.	Tons.	Cwt.
1903 . .	4	1
1904 . .	9	1
1905 . .	10	19
1906 . .	8	18
1907 . .	6	17

The objects of the tests of 1907 were:—

(*a*) To demonstrate the manurial requirements of the soil in respect of Nitrogen, Phosphates and Potash.

(*b*) To ascertain the value of Calcium Cyanamide and Nitrate of Lime as compared with Sulphate of Ammonia.

(*c*) To discover the most profitable quantity of Superphosphate.

(*d*) To compare the effects of high grade Basic Slag with low grade Basic Slag.

What does the Soil Require ?

As stated in previous reports the five plots which are laid out to demonstrate the soil's requirements are included partly for educative purposes, but also to provide data, along with chemical and mechanical analysis of the soil, for the final production of a manuring map of the North-Eastern Counties. The intention and procedure are described in Bulletins 1 and 3. The figures below show the results of five years' tests and confirm the general knowledge that Phosphates are the most necessary ingredient for the turnip crop and usually the most deficient. In 1907 there is only one exception to the rule, *viz.*, at Powburn, Fordoun. In addition to their scientific value, in conjunction with soil analysis, those plots demonstrate the slight importance of Nitrogen for the turnip crop in the North of Scotland.

When artificial manures are used alone, the absence of Nitrogen is usually apparent in the crop, but when an ordinary dressing of cake-fed dung is applied, only the smallest quantity of Sulphate of Ammonia or Nitrate of Soda is likely to prove profitable. The same remarks apply to the use of potash manures, with the explanation that Potash is sometimes much more important than Phosphates or Nitrogen. (For striking examples of the importance of Potash see previous reports.) In 1907 Potash was more important than Nitrogen on half the farms, while on all but one Phosphates were absolutely necessary.

The obvious conclusion to be drawn from five years of field trials is that to which practically all similar experiments have tended, *viz.*, that in absence of definite knowledge of the peculiarities of a soil, a complete or balanced dressing of artificial manures, with or without dung, is likely to be most profitable for the turnip crop. This principle is now so firmly established that in future reports the figures from the "five plot test" will be given, but only the exceptions to the rule will be noted. When sufficient data accumulates the subject will be discussed in the light of soil analyses.

The New Nitrogenous Manures.

Calcium Cyanamide was tested on twelve farms in 1906 and proved slightly inferior to Sulphate of Ammonia. When put on trial again in 1907 it did nothing to improve its position ; on four

farms it produced rather more crop, but on the remaining eight Sulphate of Ammonia was the better manure. In 1907 Nitrate of

TABLE I.

SHOWING THE EFFECT OF OMITTING IN TURN, POTASH, PHOSPHATES AND NITROGEN, FROM A MIXTURE OF ARTIFICIAL MANURES.

Plot.	Manures in 1907.	Yield in 1903.		Yield in 1904.		Yield in 1905.		Yield in 1906.		Yield in 1907.		Average Yield in Five Seasons.	
		Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.
1	No Manure . .	4	1	9	1	10	19	8	18	6	17	7	19
2	$\frac{6}{7}$ Cwt. Sulphate of Ammonia . 5 Cwt. Superphosphate . . 1 Cwt. Sulphate of Potash . .	12	10	20	7	21	10	22	7	17	8	18	16
3	$\frac{6}{7}$ Cwt. Sulphate of Ammonia . 5 Cwt. Superphosphate . . No Potash . . .	9	15	16	3	19	17	19	12	15	2	16	2
4	$\frac{6}{7}$ Cwt. Sulphate of Ammonia . 1 Cwt. Sulphate of Potash . . No Phosphate .	6	0	11	4	12	10	11	19	9	15	10	5
5	5 Cwt. Superphosphate . . 1 Cwt. Sulphate of Potash . . No Nitrogen . .	11	4	18	12	19	0	19	3	14	17	16	11

Plot 2 received the standard dressing, *viz.*, 20 lb. Nitrogen, 100 lb. Phosphoric Acid, 40 lb. Potash per acre.

Note.—In 1903 Nitrate of Soda was used, and a smaller quantity of Superphosphate.

Lime was tested on the turnip crop for the first time in the North. This manure is a yellow chalk-like substance, containing 12 to 13

per cent. of nitrogen which is obtained from the air like that of Calcium Cyanamide. Exactly the same quantities of Nitrogen, *viz.*, 20 lb. per acre, were applied to plots 2, 6 and 7, and if we exclude from the average, Novar Mains (where the inferiority of Calcium Cyanamide and Nitrate of Lime is quite inexplicable), the results from eleven centres are decidedly favourable to Nitrate of Lime.

TABLE II.

SHOWING THE COMPARATIVE MERITS OF SULPHATE OF AMMONIA, CALCIUM CYANAMIDE AND NITRATE OF LIME.

AVERAGE OF 11 CENTRES.

PLOT.	MANURING.		CROP.	
			Tons.	Cwt.
7	Nitrate of Lime as Nitrogenous Manure . .		17	3
2	Sulphate of Ammonia	Do.	16	12
6	Calcium Cyanamide	Do.	15	17

It is satisfactory to discover that those two manures can compete successfully with Sulphate of Ammonia. There is no reason to doubt that when they are produced in sufficient abundance they will have a healthy effect, from the farmer's point of view, upon the prices of Nitrate of soda and Sulphate of ammonia.

Calcium Cyanamide was in all cases applied with the seed on which it appeared to have no detrimental effect.

What is the Best Quantity of Superphosphate?

Previous field trials having shown the general superiority of Superphosphate as a source of phosphate it became desirable to ascertain the most profitable quantity. For this purpose plots 8, 2 and 9 were dressed with 2½, 5 and 10 cwt. of Superphosphate, while all received the same quantities of Nitrogen and Potash. The average figures clearly show the benefit from the larger dressings. When the individual returns are inspected it appears that 5 cwt. are effective over 2½ cwt. nine times out of twelve and the exceptions do not show great differences. Further, 10 cwt.

are effective over 5 cwt. nine times out of twelve, produce exactly the same crop twice, and are slightly inferior to 5 cwt. only once. The crucial question is the cost of the increased crop.

TABLE III.

SHOWING THE EFFECTS OF INCREASING THE DRESSING OF SUPERPHOSPHATE FROM 2½ TO 10 CWT. PER ACRE, WITH SULPHATE OF AMMONIA AND POTASH SALTS IN EACH CASE.

Plot.	Manuring.	Yield.		Increase over Plot 8.		Cost of Manures.			Profit or Loss.		
		Tons.	Cwt.	Tons.	Cwt.	£	s.	d.	£	s.	d.
8	2½ Cwt. Superphosphate.	15	18	—		1	7	3	—		
2	5 Cwt. Superphosphate.	17	8	1	10	1	17	6	0	1	9 (Loss.)
9	10 Cwt. Superphosphate.	18	7	2	9	2	17	3	0	10	10 (Loss.)

Comparing the increase of crop with the cost of the manures on Table III. it will be seen that 5 cwt. of Superphosphate is able to produce only 30 cwt. more turnips than 2½ cwt. of the same manure; there is thus a loss of 1s. 9d., and the loss is, of course, greater where 10 cwt. is the dressing. It does not follow, however, that 5 cwt. is an unprofitable quantity to apply, for the residual value is not taken into consideration.

High Grade versus *Low Grade Slag.*

The relative value of high grade Slag, containing (say) 37 to 40 per cent. of phosphate, compared with low grade Slag analysing 20 per cent. or thereby of the same substance, is a frequent subject of discussion. An attempt has been made to throw light on the matter by means of plots 10 and 11.

Those two plots received the same quantities of Nitrogen, Phosphates and Potash, but on plot 10 the phosphate was derived from 5 cwt. of high grade Slag analysing 37·56 per cent. of phosphate, and on plot 11 from about 9 cwt. of low grade Slag analysing 20·77 per cent.

TABLE IV.

SHOWING THE COMPARATIVE MERITS OF HIGH GRADE AND LOW GRADE BASIC SLAG.

PLOT.	MANURING.	CROP.		COST OF MANURES.			VALUE OF CROP.		
		Tons.	Cwt.	£	s.	d.	£	s.	d.
10	High Grade Slag . .	16	11	1	12	2	6	12	4
11	Low Grade Slag . .	16	6	1	14	6	6	10	4

The average figures indicate that there is little to choose between them, for the difference of 5 cwt. is too small a percentage of the total to base an opinion upon. If the individual returns are carefully inspected, and the two farms which show the greatest divergences excluded, the average difference remains much as before, *viz.*, 3 cwt. There is some reason to think that the low grade Slag, containing as it does a greater proportion of lime, has proved more effective on land which requires liming. At Gloies, Monymusk, and at Broomhills, Kintore, for example, plot 7 which is manured with Nitrate of Lime produces larger crops than plot 2 which received Sulphate of Ammonia, and at the same centres plot 11 which receives the larger quantity of lime in Slag, yields several tons more than plot 10. It would therefore seem that land which is suspected to be deficient in lime should receive the benefit of the doubt and the low grade Slag, but further investigation is necessary.

Effect of Distilleries Fertiliser.

Request was made by the Combination of Rothes Distillers that the Distillery Fertiliser, which is a bye-product and has considerable manurial value, should be tested by the College. The trial was made at eleven centres (see plot 12), not on the basis of its composition, but on the basis of equal money values, that is to say, plot 12 received that quantity of the fertiliser which was equal in money value to the mixture applied to plot 2.

Plot 2 was dressed with, approximately, 6¾ cwt. per acre, costing £1 17s. 6d., and the quantity of Distillery Fertiliser which

could be bought for the same number of shillings was $6\frac{1}{2}$ cwt. The following table shows that the Distillery Fertiliser has proved far inferior to the mixture on plot 2 as a producer of turnips, though that it has a decided manurial value is clear, by comparing it with the unmanured plot, which produces little more than half the crop.

TABLE V.

SHOWING THE CROP OBTAINED BY THE USE OF DISTILLERY FERTILISER OF EQUAL MONEY VALUE TO THE STANDARD DRESSING ON PLOT 2.

PLOT.	MANURING.	PER CENT. OF N.	PER CENT. OF PHOS.	PER CENT. OF POTASH.	CROP PER ACRE.	
2	$\frac{7}{8}$ Cwt. Sulphate of Ammonia . 5 Cwt. Superphosphate . . 1 Cwt. Potash Salts . .	20	100	40	17	8
12	Distillery Fertiliser . .	42	41	33	14	6
		(Approximately)				

It should be kept in mind that this fertiliser was compared at a disadvantage, as the proportions of its ingredients are very different from the proportions of the mixture of plot 2.

A comparison on the basis of composition would be more satisfactory and will probably be made.

TABLE VI.

Showing the System of Manuring, the Yield of Crop at Each Centre, the Cost of Manures and the Profit in Excess of Plot 1, all per Acre.

Number of Plot.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Name of Experimenter.	No Manure.	1 Cwt. Sulphate of Ammonia. 5 Cwt. Superphosphate. 1 Cwt. Potash Salts.	1 Cwt. Sulphate of Ammonia. 5 Cwt. Superphosphate.	1 Cwt. Sulphate of Ammonia. 1 Cwt. Potash Salts.	5 Cwt. Superphosphate. 1 Cwt. Potash Salts.	1 Cwt. Calcium Cyanamide. 5 Cwt. Superphosphate. 1 Cwt. Potash Salts.	1¾ Cwt. Nitrate of Lime. 5 Cwt. Superphosphate. 1 Cwt. Potash Salts.	1 Cwt. Sulphate of Ammonia. 2¾ Cwt. Superphosphate. 1 Cwt. Potash Salts.	1 Cwt. Sulphate of Ammonia. 10 Cwt. Superphosphate. 1 Cwt. Potash Salts.	1 Cwt. Sulphate of Ammonia. 5 Cwt. High Grade Slag. 1 Cwt. Potash Salts.	1 Cwt. Sulphate of Ammonia. 9¾ Cwt. Low Grade Slag. 1 Cwt. Potash Salts.	6¾ Cwt. Distillery Fertiliser.
	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.
Mr. Robt. King, Powburn, Fordoun	11 10	16 5	14 15	13 5	12 15	16 5	14 10	17 0	16 5	15 15	15 15	16 5
Mr. John Pratt, Green of Raemoir, Banchory . .	7 15½	15 7½	12 12½	10 14½	15 18½	16 15¾	16 9¾	14 12	16 5¾	16 6¼	15 4¾	13 3½
Mr. W. R. Mathieson, Gloies, Monymusk	8 7½	15 13	13 5½	11 11¾	12 13¾	11 9¼	20 15½	14 0½	16 6	14 9¼	17 7¼	—
Mr. A. McBeath, Brownhill, Slains	8 2	16 0	16 2½	10 2½	10 4½	16 6	16 1¾	14 12½	15 10	17 0½	15 11	10 8
Mr. W. A. Carnie, Broomhill, Kintore, ...	9 6½	19 11½	16 1½	10 14	20 0½	19 7½	23 3	18 6½	22 5¼	18 10½	20 14	14 15¾
Mr. Jas. Mitchell, Little Dens, Blackhills, Peterhead . ,	4 10	17 19½	15 10	4 10	18 1¾	19 12¼	19 13¾	19 0	21 4	18 7½	14 11	14 7¼
Mr. James Paterson, Brawlands, Rhynie . . .	3 6¾	14 6½	11 8¼	6 10	12 17¾	13 0	13 4½	12 17	15 10¾	12 8	12 12	9 3
Mr. A. J. Ogilvie, Ternemnay, Knock	4 5¼	15 4½	12 11	5 18¼	13 4¾	13 8	13 13¾	11 12	15 9¼	13 1	13 5½	9 12
Mr. John Lawrence, Balnamoon, Grange . . .	5 7¾	13 15	13 15¼	5 16¾	9 13	12 11	14 2¼	11 0	15 10	12 10½	11 7½	12 5¼
Mr. J. Robertson, Barmuckity, Elgin . . .	5 15	16 10	11 0	7 0	12 10	16 0	15 10	17 10	16 10	16 5	16 5	10 0
Mr. D. Moore, Novar Mains, Novar	7 5¼	26 7¼	25 12½	16 12¼	22 14½	21 7¾	20 7	21 15	26 15¾	25 0½	24 2¾	25 15¾
Col. Ross, Mains of Cromarty, Cromarty	—	22 2¼	18 11½	14 8¼	17 12¾	19 14½	20 6	18 16½	22 7¼	19 0¾	17 18¼	21 10
Average	6 17	17 8	15 2	9 15	14 17	16 6	17 6	15 18	18 7	16 11	16 6	14 6
Cost of Manures . .	—	£1 17 6	£1 11 4	£0 17 4	£1 6 2	*£1 17 6	*£1 12 8	£1 7 3	£2 17 3	£1 12 2	£1 14 6	£1 17 6
Profit in Excess of Plot 1	—	£2 6 11	£1 14 8	£0 5 9	£1 17 10	£1 18 1	£2 10 10	£2 5 2	£1 14 8	£2 5 5	£2 1 0	£1 2 0

ROTATION EXPERIMENT.

However valuable may be a knowledge of manurial effects upon specific crops, that knowledge is limited and loses much of its potential utility if the residual actions of the manures on subsequent crops are not also understood and made to form the basis of purchase and application. Ignorance of the residual values of manures may lead to frequent errors in valuations; assumptions in regard to the lasting values of manures may result in great waste of money. In the one case an outgoing tenant may receive far more or far less than his manures are worth, in the other, an expensive fertiliser may have less residual effect than a cheaper manure showing quicker results. Few experiments to determine the residual value of fertilisers have been undertaken in the North, and though much has been learned from Rotation experiments in the West of Scotland and in England, there is no surety that the results of southern experiments will be obtained on northern fields.

A number of Rotation experiments have therefore been organised in several of the Northern Counties. None are completed, but the figures from one of them are available for three years and are now included in this report. The experiment referred to is designed to ascertain the residual value of our common phosphatic manures. Those manures are so universally used that scarcely an arable farmer has not applied all of them and made choice of one or other as the source of the phosphates required on his farm. The cumulative effects of his choice may well make the difference of the rent of the land, and it is the object of this experiment to demonstrate the measure of that difference.

District and Soil.

The experiment is carried out on the farm of Midtown, Cornhill, Banffshire, occupied by Mr. Walker. The soil is a medium

loam in very good condition, too good for such an experiment, as it does not sufficiently demonstrate the methods of manuring. There are nine plots, each $\frac{1}{4}$ of an acre in extent, and the first four plots receive the standard dressing of 20 lb. Nitrogen, 100 lb. Phosphoric Acid, and 40 lb. Potash per acre, but on each plot the phosphoric acid is derived from a different source. Plot 5 is unmanured, and plots 6, 7, 8 and 9 are dunged at the rate of 10 tons per acre, and receive 10 lb. Nitrogen, 50 lb. Phosphoric acid, and 20 lb. Potash per acre, or just half the quantities applied to the first four plots. The last four plots are therefore duplicates of the first four, with the difference that half the artificial manure is omitted and replaced by dung. The following table shows the kinds and quantities of manures and the yield of crop per acre in each of the three years. (See Table VII.)

Turnip Crop of 1905.

The first column of the table gives the turnip crop of 1905, and the first five plots confirm what many other field experiments have demonstrated, *viz.*, that Superphosphate, Slag, Bone Meal and Ground Mineral Phosphates are useful as turnip growers in the order in which they occur in the table. Superphosphate may be relied upon to produce the largest crop of turnips, and Ground Mineral Phosphate the smallest when used without dung. Plots 6, 7 and 8 show that Superphosphate, Slag and Bone Meal fall into the same order when used along with dung, but here we find an unusual result, Ground Mineral Phosphate produces the largest crop. This result is somewhat surprising, but it has been found to occur in other places when dung was part of the dressing. So far as the crop of 1905 is a guide, the best manure is Superphosphate without dung and Ground Mineral Phosphate with dung, but in the last four plots the differences are slight.

Barley Crop of 1906.

In 1906 we expect the residues of the manures to appear, especially the residue of the slow-acting Bone Meal. No result could be further from the expectation. The most impressive returns of the barley crops are the failure of Bone Meal and the excellence of the crop from the unmanured plot, which yields considerably more grain and straw than plot 3 to which Bone Meal

was applied. Of the first four plots the best crop, on the whole, is from Basic Slag. Turning now to plots 6, 7, 8 and 9, which are manured more in accordance with ordinary farming practice, we find Bone Meal producing again the smallest crop, while Superphosphate produces the largest.

Hay Crop of 1907.

In 1907 when the plots are in hay we expect to find the slower manures, Bone Meal and Ground Phosphate doing better than their soluble, quick-acting rivals, Superphosphate and Slag, and we are not entirely disappointed. The residue of the Superphosphate, however, in the first plot, is still capable of producing more hay than Bone Meal, but Bone Meal is a little more productive than Slag and Ground Phosphate.

The rotation is not completed; two more crops must be weighed before the land is again in turnips, but at the end of three years it is permissible to state the financial aspect so far as it goes. In the following table the values of the crops are stated according to the prices mentioned, and the total values of the three crops compared with the cost of the manures. The manures cost as follows, with 5s. per ton added for carriage of the artificials.

Sulphate of Ammonia . . .	14s. per cwt.
Sulphate of Potash . . .	11s. 6d. per cwt.
Basic Slag	2s. 9d. per cwt.
Superphosphate	3s. 3d. per cwt.
Bone Meal	6s. 7½d. per cwt.
Ground Florida Phosphate . .	3s. 7½d. per cwt.

Dung was estimated at 5s. per ton and the crops are debited with it at the following rates—one half to the turnip crop, one quarter to the barley, and one eighth to the hay, or seven eighths in all to the three crops.

The pecuniary returns are interesting and surprising. (See Table VIII.) Compared with plot 5 which was unmanured, Superphosphate has given a profit of 20s. per acre, Basic Slag 17s. 3d., Ground Florida Phosphate 5s. 9d., and the application of Bone Meal has resulted in a loss of 27s. 3d. per acre. When

the above manures are applied along with dung they all leave a profit, by far the largest profit being from Ground Florida Phosphate. There is no control plot which received ten tons of dung alone, so it is impossible to say how much of the increase is due to the artificials, and how much to the dung.

The profits are not large, but they are certainly larger than the figures indicate, for the aftermath, or second cut of hay, is not included in the values.

I am indebted to Mr. W. M. Findlay, N.D.A., for assistance in compiling the tables.

TABLE VII.

ROTATION EXPERIMENT, SHOWING THE PRODUCE OF TURNIPS, BARLEY AND HAY DURING 1905, 1906, 1907, FROM MANURES APPLIED IN 1905.

Plot.	Manurial Treatment. Standard Dressing per Acre. 20 lb. Nitrogen. 100 lb. Phosphoric Acid. 40 lb. Potash.	1905. Turnips. Yield per Acre.			1906. Barley. Grain per Acre.		1906. Barley. Straw per Acre.		1907. Hay. Yield per Acre.	
		Tons.	Cwt.	Lb.	Bu.	Lb.	Cwt.	Lb.	Cwt.	Lb.
1	98 lb. Sulphate of Ammonia 82 lb. Potash Salt . . 680 lb. Superphosphate .	22	1	32	46	20	39	92	47	0
2	98 lb. Sulphate of Ammonia 82 lb. Potash Salt . . 594 lb. Basic Slag . . .	21	14	0	48	4	36	108	44	56
3	20 lb. Sulphate of Ammonia 82 lb. Potash Salt . . 415 lb. Bone Meal . . .	20	6	48	39	52	36	60	45	28
4	98 lb. Sulphate of Ammonia 82 lb. Potash Salt . . 297 lb. Ground Florida Phosphate	19	18	0	47	44	37	12	44	0
5	No Manure	16	18	48	45	44	38	12	41	0
6	10 tons Dung . . . 50 lb. Sulphate of Ammonia 41 lb. Potash Salt . . 340 lb. Superphosphate .	23	11	0	53	0	44	56	47	16
7	10 tons Dung . . . 50 lb. Sulphate of Ammonia 41 lb. Potash Salt . . 297 lb. Basic Slag . . .	23	6	0	50	44	41	68	47	0
8	10 tons Dung . . . 50 lb. Sulphate of Ammonia 41 lb. Potash Salt . . 207 lb. Bone Meal . . .	23	1	0	50	16	38	96	48	72
9	10 tons Dung . . . 50 lb. Sulphate of Ammonia 41 lb. Potash Salt . . 148 lb. Ground Florida Phosphate	24	7	0	49	32	43	24	50	0

TABLE VIII.

ROTATION EXPERIMENT, SHOWING THE MONEY VALUE OF EACH CROP, THE TOTAL VALUE, THE COST OF THE MANURES AND THE PROFIT OR LOSS (—) RESULTING FROM THE USE OF THE MANURES.

Plot.	Treatment. (See Table VII. for Full Dressing.)	1905. Turnip Values per Acre.	1906. Barley Values per Acre. Grain.	1906. Barley Values per Acre. Straw.	1907. Hay Values per Acre.	Total Value of Three Crops.	Cost of Manures per Acre.	Profit or Loss from the Use of the Manures.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1	Source of Phosphate—Superphosphate .	8 16 6	7 3 11	2 19 9	5 17 6	24 17 8	2 0 5	1 0 2
2	Do. —Basic Slag . .	8 13 7	7 9 3	2 15 6	5 11 3	24 9 7	1 15 3	0 17 3
3	Do. —Bone Meal . . .	8 2 7	5 14 8	2 14 9	5 13 1	22 5 1	1 15 6	–1 7 6
4	Do. —Ground Florida Phosphate	7 19 2	7 8 3	2 15 8	5 10 0	23 13 1	1 10 3	0 5 9
5	No Manure	6 15 4	7 2 1	2 17 2	5 2 6	21 17 1	—	—
6	Source of Phosphate—Dung and Superphosphate	9 8 5	8 4 6	3 6 9	5 17 10	26 17 6	3 3 11	1 16 6
7	Do. —Dung and Basic Slag . .	9 6 5	7 17 7	3 1 5	5 17 6	26 2 11	3 1 4	1 4 6
8	Do. —Dung and Bone Meal . .	9 4 5	7 16 1	2 18 4	6 1 7	26 0 5	3 1 6	1 1 10
9	Do. —Dung and Ground Florida Phosphate	9 14 10	7 13 10	3 4 10	~~8~~ 6 5 0	~~28~~ 26 18 6	2 18 10	~~4~~ 2 2 7

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 11

REPORT

I.

ON OAT EXPERIMENTS

2.

ON MILLING TESTS OF OATS

3.

ON FIELD TRIALS OF BARLEY

1907

BY

R. B. GREIG, F.H.A.S., F.R.S.E.

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1909

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REPORT ON OAT EXPERIMENTS, 1907.

The weather of 1907 was, in the first place, so unfavourable to the uniform growth of grain crops, and latterly so disastrous to their harvesting in good condition that the field experiments of that year cannot be regarded as giving more than a general indication of the comparative merits of the varieties which they were designed to test.

This summary of the results, however, is published to maintain the series (of which this is the fifth report), to satisfy the natural curiosity of those who attended the demonstrations upon the growing crops, and to throw what light is possible on the behaviour of different varieties of oats under exceptional weather conditions.

The report deals with :—

(*a*) The comparative merits of different varieties of oats.
(*b*) The effects of mixing seed of two varieties.
(*c*) The milling properties of several varieties.
(*d*) A variety test of barley.

Comparative Merits of Different Varieties.

All plots were one tenth of an acre in extent and all the varieties were duplicated at each farm. All plots except those on which Potato was sown received the same number of grains per acre. It has been found that Potato always tillers or stocks better than the others, and therefore requires less seed. The large grained kinds were sown at the rate of $3\frac{1}{4}$ million seeds per acre, and Potato at the rate of 3 million.

These quantities are represented by the number of bushels stated below.

Banner	$6\frac{1}{4}$ bushels.
Abundance . . .	$7\frac{1}{8}$,,
Potato	5 ,,
Thousand Dollar . .	$6\frac{1}{2}$,,
Universal . . .	$8\frac{1}{2}$,,

Banner and Thousand Dollar are American oats. The former has proved remarkably successful as a grain grower in many districts of the North, and the latter, which has a good reputation in some parts of England, has also been found to do well. Abundance, or New Abundance, is a cross-bred oat produced by Garton Bros., and Universal, which is said to be the earliest oat in cultivation, comes from the same firm. Potato, probably the most widely grown oat in Scotland, is used as a basis for comparison.

The test was made at eight farms and there should therefore have been sixteen plots of each variety for comparison, but inspection during the autumn eliminated three farms from the list.

At Candacraig, on a low-lying field near the river, the grain was almost drowned out by floods and rain ; at Mulben a remarkably fine crop was laid and twisted long before it was ripe, and the uncertainty of the result is shown by the yield of Banner which is scarcely more than half the yield of Potato ; at Castle Grant the crops were also laid unequally, and a slight accident to the mill during the threshing still further invalidated the figures.

At the remaining five farms the plots were damaged more uniformly and the duplicates agree fairly well.

Grain Production.

Table I shows the individual and average returns from the ten plots and as in former tests establishes the superiority of the new varieties as grain producers, with one exception.

Variety.	Average yield of dressed grain, centals.	Bushels of 42 lb.
Thousand Dollar . . .	30·37	$72\frac{1}{4}$
Banner	29·02	69
Abundance	27·71	66
Potato	25·80	$61\frac{1}{2}$
Universal	23·87	$56\frac{3}{4}$

Thousand Dollar thus gives 11 bushels more than Potato and 15 more bushels than Universal, or taking Potato as the basis of comparison, it produces 7 bushels less than the average of the three superior varieties. The older and hardier strains long grown in Scotland are more likely to withstand ungenial weather, and so it is remarkable that the new varieties should still, in such a year produce more grain. The experience of those who tried some of the new varieties is interesting and perhaps as valuable as figures, when the character of the season is remembered.

It is reported, for instance, that Banner was ready to cart three days sooner than Potato, that it grew less in the stook, and the straw having better withstood the damp, was better relished by cattle. As the American varieties stood up longer on the whole than Potato and Sandy some very heavy crops have been reported, as much as 10 quarters per acre over large areas. On the other hand, there are places where the wet spring thinned out the Banner considerably and where Potato appeared to give the larger crop. It is significant that at Candacraig, Potato suffered less from the drenching than the others.

The Universal proved a failure. This oat is undoubtedly very early, but it succumbed to rust so completely that the straw was useless except for litter.

Those field trials of 1907, in spite of the season, show how valuable the new oats may be in some districts, for example, at Sunnyside, Wartle, where the test was carried out with the greatest possible care and accuracy, Banner produced 2 qrs. 5 bush. more grain per acre than Potato, but it cannot be repeated too often that the wise course is for every farmer to experiment for himself and to measure the land and weigh the produce, for at Sunnyside, the Universal was believed by many to promise the best return, whereas it threshed the smallest crop.

Straw Production.

Only four centres are available for straw returns and they are even less trustworthy than the figures for grain. As usual the Potato gives the most straw, and on the average Abundance and Banner are 8 cwt. less productive. In a wet year Potato and similar strains easily eclipse the rest in straw production, but in a wet year there is usually plenty of straw from whatever variety,

and in a drier season as in 1906 Potato falls back into mediocrity and is equalled by the better strains as a straw grower and completely outclassed for grain.

Light Grain, and Weight per bushel.

Thousand Dollar on the whole showed a smaller proportion of light grain than the rest, while Banner and Potato gave the most.

The weight per bushel was naturally low and in no case exceeded 42 lb. natural. Abundance and Potato weighed best as a rule and Universal worst.

Earliness.

The lateness or earliness of a strain was of more importance than usual last year. Records were kept by five experimenters and as they agree almost precisely we may consider them entirely trustworthy. The average number of days required for growth was as follows :—

Variety.	No. of Days.
Universal . . .	167
Thousand Dollar . .	172
Abundance . . .	173
Banner	178
Potato	180

Potato was thus nearly a fortnight later than Universal, a week later than Thousand Dollar and Abundance, and two days later than Banner.

Varieties Grown for Seed at Gillahill.

Seven varieties of oats were grown for seed, for the College in 1908, by Mr. Porter of Gillahill, Countesswells, and though the season was peculiarly unsuitable for the field on which they were grown, and the crop was much damaged in stook, the results are worth recording, as one or two of the varieties have not hitherto been grown in the North on a large scale.

The plots were each half an acre in extent, and the oats followed turnips.

TABLE I.

SHOWING THE INDIVIDUAL AND AVERAGE RETURNS OF DRESSED GRAIN AND STRAW FROM FIVE CENTRES AND THE INDIVIDUAL RETURNS FROM THREE OTHERS WHICH ARE NOT INCLUDED IN THE AVERAGES.

	Thousand Dollar.		Banner.		Abundance.		Potato.		Universal.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	Centals.	Cwt.	Centals.	Cwt.	Centals.	Cwt.	Centals.	Cwt.	Centals.	Cwt.
Mr. Jas. Duncan, Tilliecorthie, Udny	22·25	54	29·55	54	22·05	54	28·20	63	22·70	56
Mr. Balfour, Blackpots, Auchnagatt .	31·97	43	29·40	50	30·55	50	26·72	56	23·37	43
Mr. Watt, Sunnyside, Wartle . .	35·35	42	36·10	48	33·70	43	27·15	52	26·15	49
Mr. W. W. Reid, Inchberry, Lentran	22·90	45	17·80	57	21·00	58	21·00	71	18·10	55
Mr. Jonathan Middleton, Glasstullich, Nigg	36·40	—	32·25	—	31·27	—	25·97	—	29·05	—
Average	30·37	46	29·02	52	27·71	51	25·80	60	23·87	50
Grain in Bushel of 42 lb. .	72¼	—	69	—	66	—	61½	—	56¾	—
Mr. A. F. Wallace, per Mr. Chas. Christie, Candacraig	5·95	26	6·30	26	6·35	23	8·05	23	7·05	23
Mr. J. Macpherson, Mulben . .	32·40	27	17·78	27	33·60	28	34·65	39	27·50	25
*The Countess of Seafield, Castle Grant	19·00	32	17·50	34	18·50	30	16·15	41	14·40	33

* Excluded from average owing to accident to threshing mill.

Variety.	Dressed Grain, bush.	Light Grain, lb.
Abundance	51½	154
Thousand Dollar . .	46½	163
Sensation	44¾	176
Multiplier	44¼	140
Universal	40¾	154
Mounted Police . . .	40⅛	168
Banner	38½	168

Test of Large and Small Seed.

The late Mr. Lumsden of Navity, with the assistance of Mr. Esslemont, County Lecturer, carried out an interesting test to ascertain the effects of using small oat seed. The experiment was arranged as part of the seed-mixing test to be described. Mr. Lumsden winnowed and sized a sample of Excelsior oats until he obtained two very different sizes, one consisting of large plump oats and one of very small seed. As the two lots were from the same field and the same sample, it may be assumed that they were in large degree the progeny of the same plants. Unfortunately the same bulk of seed and not the same approximate number of grains was sown on each plot, so that the small seed would be more thickly sown than the large.

	Dressed Grain, bush.	Light Grain, lb.	Straw, cwt.
Large Seed . .	50½	360	44
Small Seed . .	52⅛	520	41

The small seed produced considerably more grain, both heavy and light, than the large seed, but 3 cwt. less straw.

Mixing Seed of Two Different Varieties.

The object of this test, to discover if mixed seed will give a better yield than seed of a single variety, has been fully described in Leaflets 2 and 4.

The plots were, as usual, one tenth of an acre, duplicated, and the quantity of seed as in the variety test, but as seed of different origin was used the bushels required per acre were :—

Banner	6¼ bushels.
Siberian	6½ ,,
Banner and Siberian . . .	6½ ,,
Siberian and Scots Birlie . .	5¾ ,,
Scots Birlie	5 ,,

TABLE II.

SHOWING THE EFFECTS OF MIXING SEED AND THE TOTAL PRODUCE OF GRAIN AND STRAW PER ACRE ON THREE FARMS.

	Banner. (1)		Siberian. (2)		Scots Berlie. (3)		Banner and Siberian. (4)		Siberian and Scots Berlie. (5)	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	Centals.	Cwt.	Centals.	Cwt.	Centals.	Cwt.	Centals.	Cwt.	Centals.	Cwt.
Daviot Branch Asylum Farm . .	27·35	47	31·00	52	24·80	54	28·95	50	24·65	48
Mr. Thomson, Burnside, Enzie . .	40·70	41	41·25	45	34·65	46	·0·15	42	34·75	47
Trustees of late Mr. Lumsden of Navity	32·20	53	31·60	51	27·95	54	31·40	44	30·[illegible]0	53
Average	33·42	47	34·61	49	29·13	51	33·50	45	30·10	49
Grain in Bushel of 42 lb. .	79½	—	82¼	—	69¼	—	79¾	—	71¾	—
Mr. Wm. Matheson, Gloies, Monymusk	18·90	32	15 80	24	16·10	31	17·35	28	16·95	29
Mr. W. McBain, Balmacaan, Glen Urquhart	22·05	35	—	—	19·50	43	25·35	37	22·50	39
Mr. J. Mitchell, Broadmuir, Port-Errol	13·20	17½	17·30	21	15·70	22	14·10	17	12·05	16
Mr. McGillivray, Craigour, Torphins	26·10	53	28·25	56	29·35	59	26·75	60	29·70	63
Mr. McWilliam, Floors, Grange .	28·00	49	26·90	52	22·10	50	20·70	61	16·80	54

The five farms above have been excluded from the comparison on account of the effects of the season.

The seed used in the tests was obtained from the experiment plots of 1906, and that in turn was obtained from the experiment plots of 1905, so that if crossing had taken place in the field, as some believe is possible, the crops of the past season should have been a collection of crosses of varied appearance and productive capacity.

On five of the eight farms on which the trials were carried out the weather dealt so severely with the experimental plots that they have been excluded from consideration. The duplicate plots at the remaining three centres agree sufficiently well to make the figures worth quotation. It may be stated at once that the results of 1907 confirm those of the previous years, *viz.*, that nothing is to be gained by mixing seed of two similar strains such as Banner and Siberian, (see columns 1, 2 and 4.) It will be observed that Banner produces 79½ bush. of grain, Siberian 82¼ and the mixed seed 79¾. Nothing can be deduced from the returns of straw, but on the average there is less straw from Banner and Siberian mixed, than from either alone.

Siberian and Scots Birlie.

When two dissimilar strains are mixed, *viz.*, Siberian and Scots Birlie, we find that the yield of the mixture is less than that of the superior variety and greater than that of the inferior variety. It will be seen that Scots Birlie (column 3) produces 69¼ bush. per acre and Siberian (column 2) gives 82¼; when they are mixed, however, the produce is 71¾ (see column 5). Though the improvement over Scots Birlie is small, depression from Siberian is great, and the test tends therefore to show, that if Scots Birlie is sown at all, it should be mixed with a superior strain. There is a little more straw from Scots Birlie than from the mixture.

Potato and Scots Birlie.

By special request a test was made at Floors to ascertain if a mixture of Potato and Scots Birlie would prove advantageous. This mixture is a common one in the North and believed to be a good one. The results were:—

TEST AT FLOORS, GRANGE.

Variety.	Grain, bush.	Weight per bush.	Straw, cwts.
Potato	51¼	42½	52
Scots Birlie . . .	52½	42	49¾
Potato and Scots Birlie	52½	42½	52

The mixture has produced about 2 cwt. more straw than Scots Birlie, but the same quantity as Potato.

Those mixing experiments have now been carried on for three years, and as nothing very definite has emerged, they will not be repeated under the same conditions in the meantime. Only two mixtures have been tested in the latter seasons, and they cannot be said to have exhausted the possibilities of profitable mixing. It is even probable that other mixtures may give excellent results, but it will be desirable to establish the principles upon which such mixtures should be made, by small experiments under expert supervision, before applying them to field conditions.

There has been no evidence to show that the different strains though grown side by side have cross fertilised each other in the field.

Milling Properties of Oats.

A prejudice has arisen against many of the new varieties of oats on account of the thick husk which it is believed makes them inferior for milling purposes. To inquire into the grounds of this prejudice is one of the objects of the oat experiments, and in Bulletins 2 and 6 of the College it is shown by means of figures, derived from numerous tests, that in many cases the prejudice is prejudice, or little more. The earlier milling tests were open to criticism because of the small quantities of grain actually milled, the quantities varying from 4 bush. to 1 qr. Experiments on a larger scale were therefore organised, and the results are now available. To ascertain the milling power of several different kinds of oats it is necessary that all should be grown on the same field under similar conditions, and this was done. But to obviate any possible effect of the soil or climate from which the seed was obtained, all the seed used in the tests was grown on one farm in the year previous to that in which the experiment was made. Three varieties were selected, Potato as the standard, Banner as a well-known and prolific variety of thick husk, and Thousand Dollar, an oat of much the same character as the last, but of slightly better quality. The crops were grown on the farms of Mr. Hutchison Berrymoss, Hatton, Aberdeenshire, and Mr. Duncan, Cowfords, Fochabers. The grain was milled by Mr. Findlay, Hatton Mill, and by Mr. Duncan, at his own mill. Four quarters

TABLE III.

SHOWING THE RESULT OF MILLING 4 QRS. OF GRAIN OF THREE VARIETIES AT BERRYMOSS, HATTON, ABERDEENSHIRE, AND 5 QRS. AT COWFORDS, FOCHABERS.

Variety.	Percentage of water.	Percentage of Husk in		Percentage of Dust in		Percentage of Meal Seeds in		Percentage of Oatmeal in	
		Raw Grain.	Dried Grain.	Raw Grain.	Dried Grain.	Raw Grain.	Dried Grain.	Raw Grain.	Dried Grain.
Berrymoss—									
Thousand Dollar . .	18·82	13·61	16·68	4·98	6·05	3·05	3·76	59·52	73·33
Potato	19·50	14·06	17·47	5·57	6·93	2·82	3·51	58·03	72·09
Banner	18·53	14·80	17·99	5·73	7·03	3·27	4·02	57·81	70·96
Cowfords—									
Thousand Dollar . .	10·71	13·69	15·33	4·17	4·66	2·95	3·33	68·51	76·66
Potato	11·90	12·79	14·53	3·87	4·39	3·27	3·71	68·21	77·36
Banner	13·69	13·69	15·80	4·76	5·53	4·17	4·83	63·69	73·79

of dressed grain of each variety were milled at Hatton and five quarters at Cowfords.

Table III. shows that at Berrymoss, Thousand Dollar gives more meal per quarter than Potato and Banner, and at Cowfords, more meal from the raw grain and slightly less from the dried grain than either.

DAVIOT BRANCH ASYLUM (1908) ONE QR. MILLED.

Variety.	Weight of dry grain.	Weight of husks.	Weight of dust.	Weight of meal seeds.	Weight of meal.	Per cent. of meal.
Banner . .	270 lb.	49	20	8	192	57·1
Siberian . .	267 ,,	48	19	6	192	57·1
Scots Birlie .	256 ,,	46	18	6	183	54·4

Mr. Grassick, Manager of the Daviot Branch Asylum Farm, made a similar test, of which the results shown above are in favour of Banner and Siberian over Scots Birlie. A test made by Mr. Stewart, Mill of Noth, with oats grown on his own land shows the superiority of Sandy and Potato over Banner.

Another test kindly made by Mr. Thomson, Burnside, Enzie, brought out the following result :—

Variety.	Weight of dressed grain milled.	Weight of meal per qr. of grain.		
	lb.	bolls.	st.	lb.
Banner	716	1	4	5
Siberian	726	1	4	3
Scots Birlie	472	1	5	12
Banner and Siberian . .	709	1	4	3
Siberian and Scots Birlie .	616	1	4	11

The average figures from five tests made at five mills with the following eight varieties is stated below :—

TABLE IV.

Showing the average percentage of meal from eight varieties tested at five mills.

		Percentage of Meal. (Average of five tests.)
Old Strains—		
Scots Birlie		60·0
Potato		59·6
	Average	59·8
Cross-breds—		
Waverley		60·2
Newmarket		59·8
	Average	60·0

	Percentage of Meal. (Average of five tests.)
Importations—	
Siberian	60·7
Thousand Dollar	60·3
Wide Awake	60·0
Banner	59·7
	60·1

(These figures appeared in a different form in Bulletin 6.)

The conditions upon which the milling properties of any variety depend are many, and to do them justice would require a report to themselves, but it may be stated without misgiving that the grounds for believing in the exceptional superiority of Potato oats as millers are few, and there is much evidence to show that several of the new varieties are quite as productive of meal per quarter and far more productive of meal per acre.

After experience of upwards of eighty milling tests, and pending further data, the following order may be taken to represent the milling value of the varieties named—if the season is good and if the conditions are similar.

First Class— Sandwich.
Second Class—Sandy.
Scots Birlie.
Abundance.
Newmarket.
Thousand Dollar.
Third Class— Banner.
Siberian.
Potato.
Fourth Class—Tartar King.
Storm King.

Variety Test of Barley.

Barley for feeding and distilling purposes being largely grown in the North, a series of trials has been arranged to test the suitability of several of the strains now in the market. In order to eliminate the effect of change of seed, all the varieties for one series were grown on the farm of Mr. Watson, Brucelands, Elgin. The seed obtained from those plots at Brucelands is used in the

experiments of 1908. The field is a light sandy loam, the seed was sown on the first of May, and the season was very unfavourable, so the crop is small. Danish Archer, the variety which gave the best yield of grain and straw has proved highly prolific in similar trials in England and Ireland. It is noteworthy that the varieties which have yielded the largest crops of grain have given the heaviest crops of straw—contrary to the usual experience with oats.

VARIETY TRIAL OF BARLEY AT BRUCELANDS, ELGIN.

Variety.	Total grain.	Light grain.	Weight per bushel.	Straw and chaff.
	bush.	lb.	lb.	cwt.
Danish Archer	43	47	54½	23¾
Maltster	42	45½	54	22¼
Standwell	39½	46	53	18½
Common Barley	39½	73½	52¾	18½
St. Madoes	37	56	52½	17
Binder	34	39	54½	16
Ideal	28¾	47½	54¼	15
Chevalier	24¾	40½	54¼	16

Copies of this Bulletin may be obtained post free on application to The Secretary, Agricultural College, County Buildings, Aberdeen.

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 12

REPORT

ON

THE USE OF VIRUS FOR EXTERMINATION OF RATS

BY

J. McLAUCHLAN YOUNG, F.R.C.V.S., F.R.S.E.

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REPORT ON THE USE OF VIRUS FOR EXTERMINATION OF RATS.

At a Meeting of the Committee held 22nd January, 1909, communications were read from Mr. Dewar, Fasque, and Mr. Cook, Waterside, regarding the plague of rats in their districts and asking if the College could in any way help the farmers in the destruction and eradication of the pest. After discussion I was authorised to proceed with some experiments with this object in view.

The methods of trapping, hunting by dogs or cats, or shooting, though excellent in a way, only tend to slightly reduce the number of rats in a large area, while the laying of poisons containing Arsenic, Phosphorous, Strychnine, Barium, or other chemical poisons is accompanied by danger to other animals and cannot thus be liberally laid over a considerable district. It is freely admitted that by one or more of these methods a farm may be cleared, but owing to the well-recognised tendency to migrate among colonies of rats the farm may at any time become reinfected. Not only do healthy rats migrate but the weakly and diseased tend to leave their usual haunts and runs because of the healthy—especially males—attacking, killing and devouring the ailing.

These characteristics suggested to bacteriologists that if some disease slowly fatal to rats, mice and other members of the rodent family, and harmless to other animals could be discovered, the rats themselves would act as carriers amongst their brethren and before dying spread the fatal infection. This line of action is based upon the well-known fact that there exist diseases which affect only animals of certain species, such as

hog cholera and swine fever in pigs, and specific diarrhoea in calves. To a very large group of organisms, to which the name "Salmonella" has been given and to which the bacteria responsible for the above-mentioned diseases belong, bacteriologists turned in the hope that a bacillus might be found, capable of inducing a disease in the rat or other rodent only.

The organisms of this group are mostly of intestinal origin and are widely distributed in Nature, but it seems they are not always pathogenic or disease producing. Usually they are harmless inhabitants of the normal intestinal tracts of man and animals, but under certain circumstances, said by some to be the presence of another organism, they become pathogenic to a marked degree to the species of animal from which they were originally derived.

At present there are at least three commercial products claiming such properties in the market, *viz.*, The Liverpool Virus, manufactured by the Liverpool Institute of Comparative Pathology in connection with the Liverpool University, The Danysz Virus, made by Dr. Danysz of the Pasteur Institute and issued by the Danysz Virus Company, London, and Ratin, sold by the Ratin Company, London.

The Danysz bacillus and the Liverpool Virus bacillus were obtained originally from the intestinal contents of rats, while it is believed that the bacillus of Ratin was isolated from the urine of a child by Neumann.

They are commercially offered as growths or cultivations of the bacteria on various media, and it is claimed that if this preparation of the microbe is devoured by rats it produces in these animals a disease affecting the intestine, which is infectious and is spread from diseased rats by means of their excrement to other rats who happen to eat food which has been contaminated by the excreta.

Within the College area, as elsewhere, rats have become so numerous as to constitute a plague and I had therefore no difficulty in arranging three large areas, at considerable distance from each other, where the different preparations would be used and the results carefully noted. As before stated the three

preparations are not poisons in the ordinary sense and the information I wished to obtain was:—

1. Is any one or all three successful in killing rats and mice?

2. Are they harmless to man, animals, birds, etc., other than rats and mice?

3. Do the diseased rats spread a fatal disease amongst their fellows?

4. Can they be readily used by unskilled labour?

5. At what cost can they be applied?

Banchory Area.

Sir Thomas Burnett, his factor and the farmers on the estates of Crathes, Raemoir, Glassel, etc., had, for some time, been considering some definite line of action against rats as they were causing very serious loss through damaged and soiled grain, stacks, sacks and property. Through Mr. Dunbar, factor, Crathes Castle, I was brought into contact with them and they willingly agreed to use the Liverpool Virus over a very considerable area and keep a record of the results while I noted the quantity used and the cost. The firm responsible for the issue of this Virus, on being made aware of the nature of the test, sent a representative to live in the district and superintend the application and from reports received he most faithfully discharged his duty.

The total number of properties treated, from Crathes Castle down to the smallest croft, was ninety-three (93) and many were treated a second or a third time depending on the extent of infestation, but as the cost had to be considered no unnecessary quantity was used.

The Virus is supplied in two forms, *viz.*:—

A. In tins containing the material ready for use.

B. In tubes containing a culture of the bacillus on nutrient medium, this having to be made up with squares of bread before being used.

For certain purposes the tubes may be superior to the tins, but for laying down in a corn-yard, in runs from stack or in farm buildings, I should advise the use of the tins, as in being

opened the contents can be immediately used. To save waste it should only be laid in the neighbourhood of fresh runs or where it is known rats are "working," and as the animal is somewhat fastidious the hand should not be used but instead a spoon or a spatula.

Being a bacteriological product—to which the sun is rapidly fatal—it should be laid, as far as is possible, in shaded places or, what is better, after the sun has gone down. It seems to be readily taken by rats—either eaten at once or carried to their store of food—but no result is appreciable for several days (4 to 7) when the animals may be noticed drowsy and dull in their movements. Owing to this fact they cannot so quickly disappear on the approach of man, and because the disease tends to give them a "blown up" appearance it was frequently reported that the rats were more numerous and seemed to be feeding on the bait. From this time onwards to about the end of the second week they became manifestly weaker and suffered from diarrhœa, which caused them to be found dying or dead in the neighbourhood of water.

It cannot, of course, be said that all the rats behaved in this manner as doubtless many were naturally immune whilst others may have recovered, but from the reports it would seem that, in many, the disease appeared weeks after the bait was laid suggesting, if not proving, that it spread from animal to animal.

At the end of April the application of the Virus in this district was completed, and I have received the following report:—

"To

"The Agricultural Department,
"Marischal College,
"Aberdeen.

"We, the undersigned, tenants, farmers, and others residing on the Estates of Crathes, Raemoir, and Glassel (Deeside), Aberdeenshire, on whose properties experiments for the extermination of rats by means of 'Liverpool' Virus have been recently conducted, have pleasure in testifying as follows:—

"(1) Numbers of dead rats and mice have been found on all properties treated with the Virus, and we are satisfied that as an exterminator 'Liverpool' Virus is a success.

"(2) There has not been any case of sickness or death to any farm stock, poultry, dogs, cats, etc. We are therefore satisfied that 'Liverpool' Virus is harmless to animals, birds, etc. (other than rats or mice).

"(3) As results take some days to show, as dead rats have been continually found since the laying of the first doses, and as both young and old rats are still being found suffering from the disease set up by the Virus, we are of opinion that such disease is conveyed from one rat to another and is infectious.

"(4) We further think that as 'Liverpool' Virus is supplied in tins ready for use and requires no preparation or manipulation of any kind, it can be strongly recommended to farmers and others as being the handiest effective remedy for rats and mice."

(Here follow the signatures of members of Committee.)

This satisfactory state of matters cannot be expected to continue unless the farmers continually harass the rats by breaking up their holes and runs and by stopping their ingress and egress continually and systematically, otherwise they cannot expect any remedy to be more than a temporary relief.

The cost of applying this Virus over the ninety-three properties visited amounts to about 11s. each, the actual cost per farm varying from £2 7s. 6d. to 2s. 6d.

From the report and the cost I consider the results obtained by the use of Liverpool Virus to be most satisfactory.

Laurencekirk Area.

In this area the subject of the rat plague was before the Fettercairn Farmers' Club and Mr. Dewar, Factor, Fasque Estate, suggested approaching the College. In due course a meeting was held, and there it was agreed to form a large area and elect a Committee to carry out the application of the "Ratin" Virus, which had been kindly offered by the manager in London at half their usual prices if the Committee would

pay the expenses (6s. 6d. per day) of the representative. This offer was made to the College and the Committee agreed to pay the expenses and to pay for the Virus on the basis of rental. The same arrangements as at Banchory were made and I received the report and noted the cost.

This Virus is supplied in tins and is mixed with milk to form a soft mass, small spoonfulls of which are then rolled in paper and placed in the runs. It is therefore slightly more troublesome than the Liverpool to apply. The rats seem to take it readily as evinced by the almost total disappearance of the coloured paper in which it was wrapped.

In the course of some days the same appearance of drowsiness and swelling, to be followed later by sores on the skin was noticed in the rats and on some farms many were found dead. After one, and in several instances two applications of this Virus, another, known as "Ratin No. 2" was applied, and it is reported after this was laid many more dead rats were seen. The makers claim this No. 2 to be pathogenic to those rats immune to No. 1, and certainly it caused the death of many rats, in a shorter period, than was noticed after laying No. 1.

The reports from this district were generally favourable, but a few informed me they knew no difference. It was suggested, by one at least, that it was fatal to hens, but there is no direct proof for this statement.

The cost of applying Ratin No. 1 and No. 2 varied from £6 to 15s. per farm, but it must be remembered that the farms are much more extensive than at Banchory.

Ellon Area.

Mr. Thos. Cook, Waterside, Newburgh, wrote asking if the College could assist the farmers in his district in their efforts to reduce the prevalence of the rat plague, as the damage done on some properties was assuming serious proportions. A meeting was held at Ellon and a Committee formed, with Mr. Cook as Chairman, the members of which agreed to become responsible for the laying down of the Virus in their respective districts and to report results to Chairman, he in turn to me.

The following week a meeting of the Committee was held at Waterside when a representative of the firm gave a demonstration as to how the Virus was prepared and laid down. The Virus used here was the "Danysz" which is supplied in tubes containing the media upon which is growing the organism. The contents of the tubes are turned into a bowl containing about a pint of water, and bread, cut into squares about the size of loaf sugar, is then thrown into the bowl and thoroughly saturated with the water containing the Virus. The bread squares are now ready for laying down, using all the precautions as in the use of the Liverpool or Ratin.

It is reported that in almost every instance the bread had entirely disappeared by next morning, and for several days afterwards the rats could be heard making sounds at if in pain. In from a week to ten days many rats were seen ill and many found dead, but by the end of three weeks the mortality seemed to stop. Mr. Cook reports that undoubtedly it was the means of killing a large number of rats and mice and many were seen ill, but probably because a sufficient quantity was not laid it did not seem to possess the contagious nature claimed by the sellers.

The firm sent no representative to superintend the application and the area was a very large one, but the Committee gave every attention to their voluntary undertaken duties. The results were somewhat disappointing, but on my recommendation this Virus is being tried in Ross-shire where better results may be obtained.

The cost of this application was approximately from £3 10s. to 10s. per farm, but for small orders the price would be considerably more.

From the reports received from the three areas I draw the following conclusions and answer the before-mentioned questions.

1. Is any one or all three successful in killing rats?

Yes. Each was successful in killing rats.

2. Are they harmless to man, animals, birds, etc., other than rats?

There was no suggestion of being hurtful to other animals except in the case mentioned in the report.

3. Do the diseased rats spread a fatal disease amongst their fellows?

In one the reports say, yes. In the second, the farmers cannot say. In the third users are of the opinion that it does not.

4. Can they be readily used by unskilled labour?

Yes. The Virus put up in tins ready for use is most convenient but if it has to be prepared it is more troublesome. If put out in tubes for preparation with bread it requires some technical knowledge.

5. At what cost can they be applied?

Over extended areas, as in this test, the cost was: Liverpool Virus for 100 acres, £1; Ratin Virus (Nos. 1 and 2) for 100 acres, £2 5s.; Danysz Virus for 100 acres, £1 10s. These prices are based on the advertised cost of each Virus.

It would be interesting and useful to ascertain to what extent the number of rats has decreased throughout the three areas during the summer, and I shall make inquiries about the beginning of the winter and furnish a supplementary report.

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 13.

REPORT

ON

EXPERIMENTS WITH NEW NITROGENOUS MANURES

1904-1908

BY

JAMES HENDRICK, B.Sc., F.I.C.
LECTURER IN AGRICULTURAL CHEMISTRY

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1909

REPORT ON EXPERIMENTS WITH NEW NITROGENOUS MANURES. 1904-1908.

Among the most important of artificial manures are the nitrogenous manures or those which supply nitrogen to the soil. The supply of nitrogen to plants has been a subject of continuous controversy and research ever since the birth of agricultural chemistry.

Nitrate of Soda and Sulphate of Ammonia.

The chief artificial nitrogenous manures in use are nitrate of soda and sulphate of ammonia. The demand for both of these is continually increasing at a rapid rate. This is due to the fact that the intensive culture of such crops as cereals and root crops by the aid of artificial manures is rapidly spreading not merely in Western Europe but in all parts of the civilised world. In 1870 the total consumption of nitrate of soda for all purposes was about 130,000 tons. In 1890 it exceeded 1,000,000 tons and at present it is over 1,750,000 tons. Similar figures could be given for sulphate of ammonia, but the total consumption of this substance, at present about 750,000 tons per annum, is not nearly so great as that of nitrate of soda.

Nitrate of soda is all derived from deposits in Northern Chili; while these deposits are very large it is known that they are not of unlimited extent, and that if the world's

demand for nitrate continues to expand in the future as it has done during the past forty years, they will be worked out in a comparatively limited period.

For these and other reasons there has been a continuous search for new sources of supply of nitrogenous manures, and from time to time a certain amount of panic has been raised lest the supplies of food-stuffs for the white races should run short owing to the increase of population and the failure of the supply of nitrogenous manures. The statements on which such scares have been founded have generally been gross exaggerations, as there is no prospect of the natural supplies of nitrate of soda, for instance, being exhausted for a considerable time to come, and further the importance of nitrate of soda to the world's supply of food-stuffs has been much overstated.

The farmer, who is a purchaser of nitrogenous manures, has a further reason for wishing well to the searchers for new nitrogenous manures. The supplies of the present chief nitrogenous manures, nitrate of soda and sulphate of ammonia, are controlled by powerful rings or syndicates, who regulate, so far as they can, the supply, so as to keep up the prices. They are working on a continually expanding market, and are therefore generally speaking in an advantageous position for their purpose. Nitrogenous manures are at present by far the dearest manures which the farmer has to buy. New substances which will introduce competition and increase the supplies in the market should be welcomed by the consumer.

The Natural Store of Nitrogen.

The great store of nitrogen in nature exists in the air. There it is free nitrogen in the chemical as well as in the monetary sense, and the supply of it is unlimited. Few people realise the great weight of the air when it is taken in large bulk. Nearly four-fifths of the air consist of nitrogen and a cubic yard of air weighs about $2\frac{1}{5}$ lb. In a cubic mile of air there are about 4,250,000 tons of nitrogen, and

in the air resting on a single square mile of country there are about 21,000,000 tons of nitrogen, equal to about 135,000,000 tons of nitrate of soda, which is as much as all the estimated store in the mines of Chili.

The leaves of plants are bathed in this unlimited supply of free nitrogen, and it has always been a natural and plausible theory that plants must be able to make use of this free nitrogen to supply their comparatively limited needs. Round this question endless controversy has raged, and many of the ablest men of science have devoted much time to investigating it. The result is that it is practically universally held to be proved that green plants take in their nitrogen not as free nitrogen through their leaves, but through their roots, and that they take it in not in the free state but in a state of combination. Even the limited number of plants which can draw upon the free nitrogen of the air do so indirectly through the agency of lower organisms which work in co-operation with their roots. In any case, quite apart from the interesting theoretical question of the method by which plants assimilate nitrogen, we know that nearly all crops respond vigorously to the application of nitrogenous manures, and that especially on poor soils it will pay well to apply such manures to most crops. If this were not the case the demand for such manures would not continue to increase so rapidly in spite of their high price.

Nitrates from the Air.

For many years past chemists and engineers have continously been trying to invent means for obtaining manures from the nitrogen of the air. An immense amount of time, money and brain power has been expended on this search.

It is now more than a century since Cavendish, one of the fathers of modern chemistry, showed that nitric acid could be obtained from the air by the use of electric sparks. For a long period this remained merely an interesting

scientific observation, incapable of yielding large scale results economically. During the last thirty or forty years great advances have been made in the applications of electricity to chemical industry, and in the methods of obtaining electric power by utilising water power on the large scale. At the same time interest in the problem of preparing nitrates from the air has been stimulated by the continually increasing demand for nitrates, especially for use as manure, and by the predictions that our present natural supplies of nitrates are bound to become exhausted in a comparatively short time. Large scale attempts were made to prepare nitrates at Niagara and elsewhere, but all of these proved unsuccessful until two Norwegians, Professor Birkeland of the University of Christiania and Mr. Eyde, an engineer, devised a furnace which has since been worked successfully on the large scale. They have established in Norway a new industry which is rapidly increasing in magnitude, and in which a part of the enormous water power which is running to waste in that country is utilised to generate electricity to work their furnaces in which the nitrogen and oxygen of the air are caused to combine. The combination of nitrogen and oxygen forms a gas which when mixed with water forms nitric acid. The nitric acid so produced is then passed over limestone, when it combines with lime to form nitrate of lime. Thus from the cheap and plentiful raw materials, air, water and limestone, nitrate of lime is obtained by the aid of electricity. This infant industry has now passed through the experimental stage, and for the last three years nitrate of lime has been produced on the large scale, and it can now be purchased through the ordinary manure dealers. Energetic steps are being taken to increase the output very greatly, and in a couple of years, when the new works at present in course of construction are completed, the production should exceed 100,000 tons per annum.

Even before nitrate of lime was upon the market in this country the writer was able through the kindness of

the producers to obtain supplies for experimental purposes and with these the experiments recorded below were carried out.

Nitrate of Lime.

Nitrate of lime is like nitrate of soda a white salt which is very soluble in water. It differs from nitrate of soda in that the nitrate which it contains is combined with lime instead of soda. This is an advantage from an agricultural point of view, for lime is a substance of use to crops and to the soil, while soda is of no use to crops and may be injurious to the condition of the soil. On the other hand nitrate of lime suffers from the grave disadvantage that it is very hygroscopic, that is, it readily draws moisture from the air and if exposed soon becomes liquid. It cannot therefore be stored in bags and when opened must be used quickly or it loses condition and becomes wet and sticky.

Nitrate of lime contains less nitrogen than nitrate of soda. As at present produced it contains about 13 per cent. of nitrogen, whereas ordinary commercial nitrate of soda contains about 15½ per cent. Its price is about the same as that of nitrate of soda per unit of nitrogen, that is its price per ton is less than that of nitrate of soda in proportion to the smaller percentage of nitrogen which it contains.

Calcium Cyanamide.

Calcium cyanamide is a quite new substance whose position and practical use as a manure have to be determined from the very beginning. In nitrate of lime we have a substance newly introduced to agriculture in bulk as a manure, but the properties and value of nitrates as manures have long been thoroughly established. In cyanamide, on the other hand, we have a quite new type of chemical substance not previously known as a manure.

Calcium cyanamide was placed upon the market as

a manure a few years before nitrate of lime and the supply of it has been gradually increasing, It has only been obtainable as a manure in this country through the ordinary channels during the past two years. As in the case of nitrate of lime the producers were good enough to supply the writer with cyanamide for experimental purposes before it could be obtained in the ordinary way through the manure trade.

Calcium cyanamide to which the names "nitrolim," "lime nitrogen" and "nitrogen lime" have been applied is now being produced in various parts of the world, such as Italy, Germany, Switzerland and Norway. The supplies which are at present being placed on the British market are obtained from Odda in Norway. None is being manufactured in the British Isles.

The method of preparing calcium cyanamide was discovered by two Germans, Professor Frank and Dr. Caro, some fourteen years ago. They were not endeavouring to prepare a manure at the time and it was only some years later that it was suggested that this substance might be used as a manure. The first experiments with it as a manure were made in 1901.

Cyanamide is prepared from calcium carbide, which in turn is prepared in electric furnaces from lime and coal. The carbide, which is well known in connection with its use in preparing acetylene for illuminating purposes is heated in furnaces and nitrogen obtained from the air is passed through it. Four tons of carbide combine with about 1 ton of nitrogen to form 5 tons of calcium cyanamide. The manufacture of carbide, and consequently of cyanamide, depends on cheap electric power, and therefore, as in the case of the manufacture of nitrate of lime, the works are situated where large supplies of electricity can be obtained cheaply.

The calcium cyanamide of commerce is a black powder with an unpleasant smell. This smell is mainly due to the presence of a little carbide which on contact with

moisture gives off the gas acetylene. Commercial cyanamide has been considerably improved in this respect during the last two years and has now far less smell than formerly. It is by no means a pure substance, but contains, mixed with the chemical substance calcium cyanamide, a good deal of carbon—to which the black colour is due—lime and other substances. It contains about 20 per cent. of nitrogen which corresponds to 57 per cent. of pure calcium cyanamide. The popular names which have been given to it, such as "nitrolim" and "lime nitrogen," are very confusing, and are apt to be confounded by the practical man with nitrate of lime.

Various modifications of the original method of Frank and Caro for making cyanamide have been introduced, and for a time rival varieties of this substance were on the market. In 1908 experiments were carried on with two rival varieties, but since then an agreement has been come to and only one variety is now on the market which is advertised in Britain under the name "nitrolim".

Calcium Cyanamide as a Manure.

Calcium cyanamide can by various means be caused to undergo change and yield up its nitrogen as ammonia. When placed in the soil such a change takes place and the nitrogen gradually changes into ammonia. In this way it acts as a manure. It is not the cyanamide which feeds the plant but the cyanamide is changed into compounds of ammonia in the soil which undergo nitrification and are thus prepared to act as plant food. In this respect the nitrogen of cyanamide corresponds to that of dung, which before it becomes available for crops has first to decay and be changed to carbonate of ammonia and has then to undergo nitrification. On the other hand the nitrogen of nitrate of lime is in a form immediately available to plants, and has no change to undergo in the soil. It is to be expected then that the action of cyanamide will not be so rapid and powerful as that of nitrate

of lime, but will be more gradual and prolonged. As both are lime compounds and contain lime they should be specially useful on soils deficient in lime.

On account of this slower action of cyanamide, owing to the fact that it has to undergo change in the soil and also because it was feared that the carbide and other substances present might be injurious to germinating seed, it was recommended by the producers that cyanamide should be applied to the soil about a fortnight before the seed was sown. The early experimenters with this substance in Germany carried out most of their experiments in pots and in these pot experiments it was found that when applied with the seed injury was caused, and that the best results were obtained by sowing the cyanamide some time before the seed and mixing it well into the surface three inches of soil. As this was a point of considerable importance in connection with the practical use of cyanamide, tests were made on it in the experiments of 1905, 1906 and 1907 when on duplicate plots cyanamide was sown before the seed and with the seed. As is shown by the results given in the tables there was little difference found between these different plots, and in no case could it be said that the braird had been injured by the application of the cyanamide along with the seed. Under the conditions of field cultivation therefore, there does not appear to be any necessity to apply cyanamide before the seed, at any-rate for grain crops.

Another point on which the producers issued a warning was that cyanamide should not be used on black moorish or peaty soils which contain an excess of sour humus matter, else noxious compounds are apt to be formed by the cyanamide. It has not been found possible to specially test this point during the course of these experiments.

Plan of the Experiments.

The experiments were begun in 1905, in which year nitrate of lime was not obtainable. The first factory for its

production on a large scale, that at Notodden, only started work in 1905. Since that year experiments have been carried out each year in which both nitrate of lime and cyanamide were used.

All the experiments were carried out under ordinary farming conditions on fields which were being cropped with cereals in the ordinary way. The land was selected so as to be as even as possible, but as is the case with all experiments carried out in the field, and especially in fields under ordinary farming conditions and not specially prepared for experimental work, considerable inequalities were found in many of the plots. Such inequalities arise from various causes, such as inequalities in depth and water supply of the soil, inequalities in texture and quality of the soil, inequalities in previous treatment and manuring, inequalities in the incidence of the attacks of birds, insect pests and other enemies of the crop and so on. As a rule we were able by careful selection of the soil in which the plots were placed to avoid glaring inequalities of quality and texture of soil, but minor inequalities arose in many cases. These it is impossible to foresee and guard against in such experiments, but when a considerable number of experiments are made the effects of small inequalities are to a large extent eliminated in the average of the experiments. At the same time it should always be borne in mind in dealing with experiments of this class that the results of no single experiment can be looked upon as reliable unless they are confirmed by the general results of all the experiments.

Similarly the experiments have been continued for a period of years because the effects of season are such that the results require to be confirmed over a series of different seasons before they can be looked upon as well established, and not merely dependent upon some peculiarity of an individual season.

In all the experiments upon cereals a similar plan was followed. The new manures were compared with sulphate

of ammonia and nitrate of soda which have now been so long in common use that their value and activity as manures are generally well known. A series of plots were manured with equal amounts of nitrogen, but one plot got the nitrogen in the form of nitrate of soda, another in the form of sulphate of ammonia, another as nitrate of lime and others as cyanamide. All the plots received equally a dressing of a phosphatic and of a potassic manure, to ensure that the crops on none of the plots suffered from any deficiency of these two essential manurial constituents. There were other two plots in every case, one of which received no manure while the other received a dressing of the phosphatic and potassic manures only. The first of these served to show the capacity of the soil without any manure and the other its capacity without any nitrogenous manure but with a liberal supply of phosphatic and potassic manure.

The plots for each year and the manuring they received are shown in Table I.

TABLE I.

NEW NITROGENOUS MANURES. FIELD EXPERIMENTS ON GRAIN. QUANTITY OF MANURE PER ACRE.

Plot.	Manure.	1905. Quantity per acre.		1906. Quantity per acre.		1907. Quantity per acre.		1908. Quantity per acre.	
		Cwts.	Lb.	Cwts.	Lb.	Cwts.	Lb.	Cwts.	Lb.
1	No manure . . .	—	—	—	—	—	—	—	—
2	Superphosphate . .	2	—	2	—	2	—	2	—
	and Potash Manures .	1	—	1	—	1½	—	1½	—
3	Same as No. 2 and Nitrate of Soda . .	1	30	1	14	1	34	1	35
4	Same as No. 2 and Sulphate of Ammonia	1	—	—	100	1	—	1	—
5	Same as No. 2 and Calcium Cyanamide .	1	—	1	—	1	3	1	21
6	Same as No. 2 and Nitrate of Lime . .	None		1	100	1	75	1	75
7	Same as No. 2 and Calcium Cyanamide .	1	—	1	—	1	3	1	18

In each year the superphosphate used was of high quality, and never contained less than 32 per cent. soluble phosphate. In 1905 and 1906 muriate of potash was the potash manure used, while in 1907 and 1908 30 per cent. potash manure salt was used.

The manures were all analysed and the amounts of the different nitrogenous manures applied were calculated from the analysis so as to supply an equal dressing of nitrogen per acre to each plot. The percentages of nitrogen found in the different manures are shown in Table II.

TABLE II.

PERCENTAGES OF NITROGEN IN THE NITROGENOUS MANURES.

MANURE.	1905. PER CENT. NITROGEN.	1906. PER CENT. NITROGEN.	1907. PER CENT. NITROGEN.	1908. PER CENT. NITROGEN.
Nitrate of Soda . . .	16·12	16·14	15·54	15·44
Sulphate of Ammonia .	20·28	20·41	20·35	20·30
Calcium Cyanamide . .	20·50	18·20	19·77	(1) 17·12 (2) 17·47
Nitrate of Lime . . .	None	9·60	12·14	12·17

The nitrate of lime used in 1906 was basic nitrate of lime, which contained an excess of lime, and therefore a low percentage of nitrogen. In 1907 and 1908 ordinary neutral nitrate of lime was used. In 1905, 1906 and 1907 Plot 5 received calcium cyanamide about ten days to a fortnight before the seed, and the cyanamide was worked into the surface few inches of the soil. Plot 7 in the same years received the same variety and quantity of calcium cyanamide at the time of seeding.

In 1908 Plots 5 and 7 received different varieties of calcium cyanamide known as "lime nitrogen" and "nitrogen lime" respectively. Both were applied at the time of seeding. The nitrate of soda and nitrate of lime were not applied at the time of seeding, but were top-dressed on the braird.

The average results for each year are given in Table

III. together with a general average for all the experiments of the years 1905, 1906 and 1908. For the reasons given below the experiments of 1907 are not included in the average.

TABLE III.

New Nitrogenous Manures. Results of Field Experiments on Grain.

Crop per Acre.

Plot.	Manure.	1905. Average of 2 Experiments. 1 Oats and 1 Barley. Grain.	1905. Straw and Chaff.	1906. Average of 3 Experiments. All Oats. Grain.	1906. Straw and Chaff.	1908. Average of 8 Experiments. 6 Oats and 2 Barley. Grain.	1908. Straw and Chaff.	Average of Experiments, 1905, 1906 and 1908. 10 Oats and 3 Barley. Grain.	Average. Straw and Chaff.	1907. Average of 7 Experiments. 6 Oats and 1 Barley. Grain.	1907. Straw and Chaff.
		lb.	cwts.	lb.	cwts.	lb.	cwts.	lb.	cwts.	lb.	cwts.
1	No manure	2495	26¾	2348	33¼	2064	26	2196	27¾	1957	36¼
2	Superphosphate, 2 cwt., and Potash Manure . . .	2645	28¾	2532	37¼	2061	26	2260	29	2250	43¾
3	Same as No. 2 and Nitrate of Soda . . .	2975	34¼	2747	41¾	2443	33	2595	35¼	2308	52¾
4	Same as No. 2 and Sulphate of Ammonia . . .	3060	32¾	2747	42	2541	36	2668	37	2415	56
5	Same as No. 2 and Calcium Cyanamide . . .	3005	32	2807	43	2551	32¾	2680	35	2225	49¼
6	Same as No. 2 and Nitrate of Lime . . .	—	—	3121	43¼	2702	37	2816	38¾	2315	50¼
7	Same as No. 2 and Calcium Cyanamide . . .	2945	32½	2847	44¼	2579	32¾	2697	35¼	2234	53¼

Experiments of 1905.

Only two experiments were carried to a successful conclusion though five were laid out in this year. In two cases mistakes were made which spoiled the experiments and in another grave irregularities in the depth and water supply of the soil became apparent as soon as a period of drought set in. These three experiments were therefore abandoned.

As the tables show no nitrate of lime was used in this year. Though it was already being manufactured on a small scale and used for experiments in Norway, Sweden and Germany, it was not obtainable in this country. The calcium cyanamide used was obtained direct from the Cyanid Gesellschaft of Berlin, who were the early manufacturers of this manure.

One of the experiments which was successfully completed was upon oats the other was upon barley. In both cases the crops obtained were considered good for the land and season. They were very even and uniform and were harvested in splendid condition.

In both experiments it was found that the cyanamide did practically as well as the nitrate of soda, or sulphate of ammonia. The nitrate of soda gave the largest yield in straw and the sulphate of ammonia in grain, but the cyanamides were very close to them. The slight differences in yield of grain between any of the plots were within the limits of error of experiment for such experiments, that is, they might have been caused by such slight irregularities as are always found in such experiments.

There was no marked difference in result between the cyanamide applied early and the cyanamide applied with the seed. The gross crops yielded in the two cases were practically identical and no injury to the braird could be detected on the plots which received cyanamide at the time of seeding. The plots which received cyanamide early started a little better than those which received the cy-

anamide late, but they did not maintain any noticeable advantage long.

It was observed that the nitrate of soda plots were in both cases latest in ripening, the sulphate of ammonia came next and the cyanamide were slightly before the sulphate of ammonia.

EXPERIMENTS OF 1906.

In this year a supply of nitrate of lime was received direct from the producers at Notodden in Norway. The nitrate of lime which they were turning out at that time was a basic nitrate and not the ordinary nitrate which is now upon the market. This material was produced for a time as an attempt to get over some of the difficulties experienced in handling the ordinary nitrate. In it the nitrate is combined with a considerably larger proportion of lime than in ordinary nitrate and the manure therefore contains a smaller percentage of nitrogen. The sample received was found, as shown in Table II., to contain only 9·6 per cent. of nitrogen. Standard sulphate of ammonia contains 20 per cent. of nitrogen and standard nitrate of soda 15·5 per cent. As the nitrate of lime contained so much less a correspondingly larger dressing had to be used to supply the same amount of nitrogen per acre.

In this season 1 cwt. per acre of calcium cyanamide was taken as the standard dressing and quantities of the other manures containing an equal amount of nitrogen were applied as shown in Table I.

The calcium cyanamide was obtained again through the Cyanid Gesellschaft of Berlin, who obtained it from the associated Italian company which was the first to manufacture cyanamide on a really large scale.

In this season three experiments, out of six started, were successfully completed. All were on oats. The average of these is shown in Table III. In all of these three experiments the crop was harvested in good condition. All three sets of plots showed minor inequalities ow-

ing to drought and other causes which caused the results to vary considerably in the different experiments. Even the average of the three is slightly affected by these inequalities.

The general result is as in 1905 that all the manured plots show a considerable increase over the unmanured. It was also generally noticed that the manured plots were somewhat earlier than the unmanured. Among the maured plots that which received nitrate of soda was generally latest. Curiously the nitrate of lime plot was on the whole earlier than the nitrate of soda one, while the cyanamide plots were earlier than either.

The plots which received the new manures come out particularly well in the averages for this year as they all show larger crops both of corn and straw than those which received nitrate of soda and sulphate of ammonia. The nitrate of soda and sulphate of ammonia plots give practically identical results, and the cyanamide plots were a little better than them in both grain and straw. The differences, however, are not sufficient to found anything upon. The nitrate of lime plot is distinctly ahead of any other in grain, but as this was due to a specially heavy return from one experiment which was probably produced by some exceptional cause, it would be unwise to draw any further conclusion from it than that the experiments show that nitrate of lime did at least as well as the other manures. The practical men who visited the experiments at the demonstrations held about the time of ripening of the crops were generally agreed from the appearance of the plots that the new manures were giving very satisfactory results, and were doing quite as well as the others.

Experiments of 1907.

There were seven experiments, six on oats and one on barley, laid out this season, and all were completed, but so disastrous was the harvest that the results obtained from the weighing of the crop cannot be looked upon as

of any importance. The average result is given in Table III. for what it is worth, but is not included in the general average of the experiments carried out in different years, as it would only render that average less reliable. The reason for the failure was the long-continued wet weather at the time of harvest, which caused such serious loss in nearly all parts of Scotland that the harvest of 1907 is likely to be long remembered. The wet weather affected the crops and spoiled the accuracy of the results in two different ways. (1) Many of the plots were badly laid. Those which were heaviest and should have yielded best, were most seriously injured in this way. (2) After they were cut, in some cases, the crop lay on the field for weeks before it could be saved, and in most cases was harvested in wretchedly bad condition. The results obtained by the eye at the inspection of the crops, before they had been spoiled by the bad weather, gave at least as accurate an idea of the effect of the manures as that which was given by the weights. In many cases the results of the weighing of the crops flatly contradicted the opinion formed by the parties of practical men who inspected the plots a few weeks before the harvest. This was mainly because the strongest and heaviest crops generally went down first, and never got a chance of ripening properly. There was only one experiment out of the seven in which the crop was saved in good condition and from which the results were at all reliable. In this case the results agreed with those obtained in the other years. Similarly the results of the inspections showed, as in other years, that the new manures gave results equal to those obtained by sulphate of ammonia and nitrate of soda. The average results from the weighing, as shown in Table III., indicate that there was very little increase in grain from the use of the nitrogenous manures, but this was due to the fact that in most cases the plots which got nitrogenous manures were earliest laid. In the case of the straw increases in weight are shown, but

the whole of the straw results are utterly unreliable, as it was nearly all harvested in damp, bad condition, and some of it was even rotted.

In this year, as in 1905 and 1906, cyanamide was applied early on Plot 5 and at seeding on Plot 7. No distinct difference was found between the two plots. In some cases one was considered to be a little ahead, and in some cases the other. In no case was any injury to the braird noticed on Plot 7, on which the cyanamide was applied with the seed. We are justified in concluding, therefore, as the result of these three years' experiments, all of which have given consistent results on this point, that it is not necessary to apply calcium cyanamide early when it is used as a manure for oats and barley, and when it is given in such dressings as were used in these experiments.

Experiments of 1908.

In this season there were eight experiments, six on oats and two on barley. The plots were as before except that the cyanamide plots received different varieties of cyanamide, and both varieties were applied with the seed. The cyanamide applied to Plot 5 was received from the North-Western Cyanamide Company Ltd., London, and was known as "Lime Nitrogen". This company had taken over the supply to Britain of cyanamide made by the original Frank and Caro process. Plot 7 received cyanamide known as "Nitrogen Lime" which was supplied by Messrs. C. Schneider & Co., Glasgow, who were then agents for Scotland for cyanamide made according to the Polzenius process, a modification of the Frank and Caro process These two varieties of cyanamide were then competing with one another, but since then they have arranged their differences, and now all the cyanamide in the British Isles is supplied through the North-Western Cyanamide Company under the names "Nitrolim" or "Lime Nitrogen" The nitrate of lime was as before received direct from

Norway. In 1908 as in 1907 it was ordinary nitrate of lime, containing over 12 per cent of nitrogen.

The percentages of nitrogen in all these manures are given in Table II. The standard dressing was taken in this season as 1 cwt. of sulphate of ammonia per acre, and all the other manures were applied in such quantity as to give an equal dressing of nitrogen.

The season was on the whole a good one. Some of the crops suffered a little from drought during the summer. Before the time of harvest there was a good deal of rain and in some of the experiments the crops on the plots which received nitrogenous manures were badly laid. Probably the average results from all the nitrogenous manure plots would have been greater but for this cause. In the case of some of the experiments it was said by practical men that the results from Plots 3 to 7, those which received nitrogenous manures, would have been better had they received a smaller dressing.

As is shown by Table III. the nitrate of lime plots came out best on the average both in grain and straw, and this average result was confirmed in the case of most of the individual experiments. Yet this plot and the nitrate of soda plot were among the worst laid.

When the experiments were visited during the growing period it was frequently noticed that the nitrate of lime plot looked distinctly darker in colour and more vigorous in growth than any other plot, and more than once the farmers who visited the plots at the demonstrations made the remark that this plot had had more manure than the others, and that it would have been better if it had had less. Similar observations were made during 1906 and 1907.

The crops from the two cyanamide plots were very similar on the average both in grain and straw. During growth also there was very little difference to be noticed between them. As was to be expected the two different varieties of cyanamide proved of very similar value on the

field. They also gave results very similar to those yielded by sulphate of ammonia. Though the sulphate of ammonia showed a rather better return in straw, this result was probably accidental, as it was entirely caused by an exceptionally heavy yield of straw on two out of the eight experiments, and on both these experiments the crop was not saved in the best of condition and the straw results were therefore a little irregular. In any case it would not be safe to insist upon it as it was not confirmed by the results of 1905 and 1906.

The nitrate of soda plots did not give quite so big a yield of grain as the other nitrogenously manured plots, but the difference is not sufficient to justify us in drawing any very definite conclusions.

Pot Experiments.

In 1908 a number of pot experiments were made with these manures and were exhibited on the College stand at the show of the Highland and Agricultural Society in Aberdeen. All the pots were filled with sand which received an all-round manuring of artificials to supply phosphate, potash, lime, magnesia and all the other ash constituents necessary to plants. The different nitrogenous manures, nitrate of soda, sulphate of ammonia, calcium cyanamide and nitrate of lime were applied as in the field experiments so as to apply equal dressings of nitrogen. The crop grown was oats.

In the pot experiments the crop had to depend entirely on the artificial manures applied, as the pure sand used, unlike the soil of cultivated fields, could not itself supply the crop with anything sufficient to maintain even the most stunted growth. The pots which received nitrogenous manures all grew well, but the nitrate of lime pots soon outstripped all the others. There was no great difference between the pots which got nitrate of soda, sulphate of ammonia and cyanamide, but the nitrate of lime pots were

taller, stronger and deeper coloured plants than any of the others.

General Results of all the Grain Experiments.

The main object of these experiments was to test the value of the new nitrogenous manures, calcium cyanamide and nitrate of lime. They have passed the test well. Grain crops were chosen for the test as they depend so much on a supply of available nitrogen.

In Table III. an average of the experiments of the three years 1905, 1906 and 1908 is given. For the reasons already stated the experiments of 1907 are excluded from this average and are given separately. This general average of thirteen experiments carried out in three different seasons shows how little grain crops are increased by a supply of phosphates and potash alone. Plot 2 only gave an average increase of 64 lb. of grain and 1¼ cwt. of straw and chaff as compared with Plot 1. On the other hand the addition of any of the four nitrogenous manures used gave a large increase in both grain and straw. Even the smallest increase in grain, given by Plot 3, nitrate of soda, was more than sufficient to pay for the cost of the manure and in addition there is a large increase in straw which is clear profit. The largest increase was given by Plot 6, nitrate of lime, and amounted to 556 lb. of grain and 9¾ cwt. straw as compared with Plot 2. This was a very profitable increase indeed.

Plots 5 and 7 which both received cyanamide give practically identical results and may be treated as one. The results from cyanamide are practically identical in grain with those from sulphate of ammonia, but sulphate of ammonia has a slight advantage in straw. For the reasons already given, however, it would be unsafe to draw any definite conclusions from this small superiority of sulphate of ammonia in straw. The results from cyanamide are slightly superior in grain to those from nitrate of soda and practically identical in straw. The superiority of the

cyanamide in grain is too slight and is not consistent enough throughout the experiments to justify any very definite conclusions. Nitrate of lime was used in only two seasons out of the three, but in both of these it gave results distinctly superior in grain to those of any of the other nitrogenously manured plots. In this case the results were very consistent throughout the experiments. In straw also the nitrate of lime has an advantage over any of the other manures. This superior action of nitrate of lime was so fully confirmed by the appearance of the plots all through the experiments that we are justified in concluding that under the conditions of these experiments nitrate of lime is somewhat superior, weight for weight of nitrogen, to nitrate of soda, sulphate of ammonia or calcium cyanamide.

The superiority of nitrate of lime over nitrate of soda was distinctly shown throughout all the experiments. This superiority was quite unexpected. Nitrate of soda is generally regarded as the most active of all the nitrogenous manures in ordinary use. Innumerable experiments in this and other countries have shown that on the average it will give for equal weights of nitrogen a somewhat superior result to sulphate of ammonia. The fact that nitrate of lime has done better in these experiments than nitrate of soda must be attributed to the lime.

Generally speaking the soils of this district are naturally deficient in lime, and frequently suffer from poverty of lime. Nitrate of lime supplies lime as well as nitrate. On the other hand nitrate of soda supplies soda, but no lime. Soda is not essential to crops and in certain circumstances may have injurious effects on the condition of the soil. Lime is essential to crops and its effect on the soil is beneficial. It is natural then to conclude that the superior action of the nitrate of lime is due to the fact that the nitrate is combined with lime which is a constituent generally deficient in our soils.

Calcium cyanamide also contains a large percentage of

lime. Probably the presence of this lime has helped to bring about the very successful results obtained from its use.

Experiments on Turnips.

In addition to the experiments on cereal crops, the new nitrogenous manures were tried upon turnips. For many years past series of field experiments have been carried on with various manures upon turnips. In these Mr. Greig, Fordyce Lecturer on Agriculture, and the present writer have collaborated and the results have been published in Bulletins.

In 1906 calcium cyanamide was tried in comparison with sulphate of ammonia. On the average of twelve experiments it proved slightly inferior to sulphate of ammonia in yield of crop. In 1907 both calcium cyanamide and nitrate of lime were tried in comparison with sulphate of ammonia. Equal dressings of nitrogen per acre were applied in the three forms, and the plots received at the same time a liberal supply of superphosphate and potash. On the average of eleven experiments calcium cyanamide came out a little below sulphate of ammonia in yield of crop, while nitrate of lime came out a little above it (see Bulletin 10, pp. 4-6).

The actual figures were :—

	Tons.	Cwt.
Nitrate of lime, average of 11 plots . .	17	3
Sulphate of ammonia, average of 11 plots .	16	12
Calcium cyanamide, ,, ,, .	15	17

It should be noted, however, that turnips are not so suitable a crop on which to test nitrogenous manures as grain. A grain crop depends more upon a sufficient supply of nitrogen than on any other manurial constituent. That is well illustrated in Table III., where phosphatic and potassic manures alone gave little increase of crop as compared with the plot which was unmanured, but where the addition of any of the nitrogenous manures greatly increased the crop.

Turnips on the other hand depend little on an artificial supply of nitrogen and much on a supply of phosphate and potash. A main reason for this is that the turnip crop is sown late in the season when the soil is already warm and nitrification is active. In any soil, therefore, in even moderately good condition, so much natural nitrate is produced in the soil by nitrification that little is needed from artificial sources during the period in which the turnip crop is in active growth.

There was one point of importance noted in these turnip experiments which bears on the use of calcium cyanamide. The turnip plant is very delicate and easily injured in its early life. It is therefore a good crop on which to test whether calcium cyanamide applied at time of seeding is injurious. As has been already stated, the producers recommend that calcium cyanamide should be applied a fortnight before the seed. In all these experiments the calcium cyanamide was applied like the sulphate of ammonia at the time of seeding. In no case was any injury to the young plants noticed. This agrees with what was found in the case of the hardier grain crops. If turnips can stand cyanamide applied at time of seeding there should be no danger in applying it in such dressings as were used in these experiments, about 1 cwt. per. acre, to any grain crop.

Experiments on the Storing and Mixing of Nitrate of Lime and Calcium Cyanamide.

The experiments already detailed indicate the manurial value of these manures when actually applied to the soil and show that they are both manures of high activity, but in addition to their manurial activity there are a number of other questions to be asked concerning them, the answers to which will affect intimately their position and use as manures and the readiness with which they will come into favour with farmers. Can these sub-

stances be easily and safely handled and stored? Can they be mixed with other manures? Can such mixtures be stored? Will they undergo deterioration on keeping? etc. It may at once be stated that both substances have properties which are not to their advantage and which will tend to cause prejudice against them. Nitrate of lime absorbs moisture with great readiness and becomes wet. That is the most serious disadvantage from which it suffers. Calcium cyanamide, on the other hand, is an unpleasant substance to handle. It is very dusty, and the dust is not only unpleasant but if breathed may actually be dangerous.

Nitrate of lime is sent out by the makers in special barrels lined with paper to exclude the air and the moisture it carries with it. In these it can be kept safely for a long period, provided the barrels are kept closed. Barrels are not so convenient for farmers to handle as sacks.

When put up in sacks nitrate of lime at once begins to absorb moisture, but it is a considerable time before it actually becomes so wet as to be unfit for use, unless it is directly exposed to wet. No soluble manure, like nitrate of soda or sulphate of ammonia, should be directly exposed to wet or it will be melted away and wasted. In experiments carried on during the winter 1908-9 in an ordinary cold cellar comparable with such a store as a farmer might use for manure, it was found that even in quite small bags nitrate of lime could be kept for two or three weeks without running to waste or even becoming too wet to sow. After a few weeks, however, it always began to waste by escaping through the bags in liquid form.

It was mixed with dry peat dust and bagged in that form, but it was found that it became wet and wasted even more rapidly when mixed with this drier than when stored alone.

Mixtures with other manures such as superphosphate, bone flour and potash salts rapidly became damp and

sticky. After a few days any such mixture got into an unsowable form.

This readiness with which nitrate of lime draws moisture and liquefies would be an advantage when it is used as a top dressing in dry weather. It would then itself liquefy and pass into the soil without the aid of rain.

Where nitrate of lime is sown by hand it liquefies on the hands of the sower and is said after a time to injure the skin and make the hands sore. When used in any quantity nitrate of lime would require to be sown by a machine, or if sown by hand the sower would require to use rubber gloves.

Calcium cyanamide when stored also absorbs moisture from the air, but the moisture enters into combination with the lime and other substances contained in the manure which does not become damp. In addition to moisture it also absorbs carbon dioxide from the air. After a time it becomes lumpy, and in time the whole mass sets into a hard lump. In my experiments calcium cyanamide stored in small bags in a cellar under the same conditions as nitrate of lime gained in weight nearly as rapidly as nitrate of lime. After a few weeks it became lumpy. After several months storage it became a hard solid lump, but never showed any sign of becoming damp.

During storage the percentage of nitrogen diminishes. This is mainly on account of the gain in weight, but a small loss of nitrogen also takes place. This is a point to which those who deal in cyanamide would require to attend. The percentage of nitrogen may diminish considerably. In one of my experiments it fell from 17·4 per cent. to 13·6 per cent. in four months. At the same time the weight of material in the bag increased about 16·8 per cent. These figures show that the fall in percentage of nitrogen was mainly due to the increase in weight.

When mixed with superphosphate or any other soluble phosphate considerable heat is given off and the phosphate is to a large extent reverted or rendered insoluble.

No loss of nitrogen was detected in such mixtures. But probably the nitrogen changes condition to a large extent. On keeping such mixtures gradually became hard. It will not be advisable to make mixtures of calcium cyanamide with soluble phosphates.

Calcium cyanamide may be safely mixed with basic slag or with bone meal or bone flour, and also with potash manures. Probably all such mixtures would become hard and lumpy after a time.

Conclusions.

The following are the main conclusions to which these experiments lead :—

1. That calcium cyanamide (nitrolim or lime nitrogen) and nitrate of lime have both proved themselves active and effective nitrogenous manures.

2. That calcium cyanamide has shown itself equal to nitrate of soda or sulphate of ammonia as a manure for grain crops.

3. That nitrate of lime has proved itself rather more effective, weight for weight of nitrogen, than nitrate of soda, sulphate of ammonia or calcium cyanamide. This is probably due to the fact that it contains lime in combination with the nitrate. The results might be different on soils well supplied with lime.

4. That no noticeable injury was caused to germination by applying calcium cyanamide at the time of seeding. There does not appear to be any necessity, therefore, for applying this manure before the seed when it is used in dressings of about 1 cwt. per acre.

5. That both calcium cyanamide and nitrate of lime possess disadvantageous properties which may limit their use. Neither is suitable for mixing with soluble phosphates.

6. That nitrate of lime absorbs moisture so readily that it will require to be protected from the air when stored,

and will not be suitable for use in our ordinary manure mixtures.

7. That the most suitable method of using nitrate of lime is as a top dressing. When so used its hygroscopic nature will be an advantage and taken along with the rapidity with which it works and its powerful forcing action will make it the most useful manure we possess for certain purposes, such as forcing on a crop which is suffering from insect attack.

Aberdeen and North of Scotland
College of Agriculture

Bulletin No. 14.

REPORT

ON

Poultry-Keeping Experiment

In connection with Gift by MR. JAMES MURRAY, M.P.

BY

MR. WILLIAM KEYS, F.E.I.S.

ABERDEEN: THE ROSEMOUNT PRESS
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Aberdeen and North of Scotland College of Agriculture.

REPORT ON POULTRY-KEEPING EXPERIMENT.

The object of the experiment was to ascertain the extent to which poultry-keeping for egg production could be profitably conducted by farmers, cottagers, crofters, and cottars. With this aim in view, eight flocks of White Wyandottes, each consisting of nine pullets and a cockerel, were purchased, and also two similar flocks of White Leghorns. These varieties were selected in consequence of their high reputation for laying qualities, and they were obtained from the most reliable known sources of bred-to-lay fowls.

Eight of these flocks or colonies were distributed on farms and kept on the colony system. The fowls were accommodated in movable houses, and had unrestricted range. The remaining two flocks were kept under conditions applicable to the fowls of cottagers and suburban poultry-keepers. Their range was restricted, and situated chiefly among shrubs and trees.

The fowls were got in the end of October of last year, with the view of commencing on 1st November, but owing

to their immaturity generally the commencement of the experiment was delayed till 1st December. During the twelve months over which it extended note was kept of the daily number of eggs laid by each flock. The actual price received for eggs sold was also noted. In the hatching season those conducting the experiments had a demand for eggs for setting, and they sold them for this purpose at 3s. 6d. a dozen, as a rule.

I give a separate report for each colony. It should help to dispel the oft-repeated statement that hens will not lay in winter. The report shows the number of eggs for each month and the price actually obtained for them. This includes extra for such eggs as were sold for hatching purposes. The information it gives is interesting, but as the extra price received for eggs intended for hatching would vary from year to year, there is placed in a parallel column their money value had they all been sold at the ordinary market rate, whether in town or country.

Some have sold eggs at the rate prevailing in their respective rural districts. This applies to those in charge of Colonies Nos. 1, 4, 5, 8, 9. For particulars of these, see column under "Price Locally (2)," page 20.

Those who had Colonies Nos. 3 and 6 sold eggs at Aberdeen prices throughout the year, whilst the owners of Colonies 2, 7, and 10 sold part at local rates and part at Aberdeen rate.

In order to bring out a comparison of the money value of the eggs of all the colonies if sold at a uniform rate, I have taken the price obtained for the eggs of Colony No. 3 as a standard, and have shown in column under "Price in Aberdeen," page 20, what eggs sold at local rates would bring if sold in Aberdeen. Whilst eggs in rural districts are, as a rule, sold at a uniform price, whether large or small, fresh or stale, it is otherwise in Aberdeen, where size and quality count. The eggs of Colony No. 3, taken as a standard, were sold at highest market rate, as doubtless would the eggs of the other colonies if similarly marketed.

By giving in parallel columns—

(1) Price Received,
(2) Price Locally,
(3) Price in Aberdeen,

an opportunity for comparison is afforded. To the right of these is the column giving "Cost of Food."

The excess of these prices over "cost of food" is given in the three columns on the right marked (1), (2), (3).

To arrive at net profits from marketing eggs in Aberdeen it would be necessary to deduct cost of carriage and any other necessary incidental expenses. In the matter of production also there are other deductions to be made besides cost of food. Houses, utensils, depreciation, and labour require to be accounted for.

It will be seen from the detailed reports which follow that there need be no difficulty in securing eggs in winter. Provided the right kind of fowls is kept, and the proper time of hatching observed, the poultry-keeper can regulate an all-the-year-round egg supply.

So far as can be ascertained, the bulk of Scottish poultry average from 70 to 90 eggs per hen during the year. Promiscuous mating and inbreeding are chief factors in producing this low average. The best in the matter of egg production can only be secured by persistent breeding year by year from selected layers, and by the use of the trap-nest the exact number of eggs laid by each hen can with certainty be reckoned. In this connection, it may be mentioned that the parent fowls of the two colonies that stand highest in number of eggs for the year were obtained from a breeder who practises trap-nesting.

The breeder from whom the greater number of colonies was obtained is more widely known than the one referred to. In his catalogue he says:—"Having for twenty-eight years made a speciality of superior laying qualities, we have, by persistently breeding from selected layers, been successful in establishing some of the finest laying strains the world has ever seen."

As will be seen from the Abstract, p. 20, the average number of eggs per hen for the year is 150.8.

The eight colonies of Wyandottes averaged 156.6 eggs for the year, and the two flocks of White Leghorns 127.5 eggs.

It will be seen from a comparison of the colonies that the Wyandottes continued to lay right through the moulting period, whereas the Leghorns did not—see Colonies Nos. 7 and 8. It is not improbable that the Leghorns may give a better account of themselves in future, as they become acclimatised.

All the ten colonies have been under careful and intelligent management, and all that it was possible to do to secure reliable results those who conducted the experiments did with evident pleasure. The difference of the colonies in total egg production is such as might be expected from local causes, combined with the diversity that exists in the laying qualities of different strains.

As will be seen from the Abstract, the average excess of price received for eggs over cost of food is 14s. 0½d. per hen. Had all the eggs been sold at the rate of those sold in Aberdeen, the excess of the price over cost of food would have been 10s. 11½d. per hen per year. The difference here is accounted for by the higher prices actually received for eggs sold for hatching purposes. Had they been sold locally, however, the profit per hen would have been considerably less.

These very favourable results are due to the superior laying qualities of the fowls selected for the experiment.

Colony No. 8 shows the smallest average and narrowest margin of profit. This arises, in part, at least, from the fact that the fowls were brought from a warmer to a colder climate, and this on the eve of winter. Their house was situated on an exposed field bordering upon moorland. In the beginning of January a severe snowstorm put them out of condition, and they did not recover their usual until the month of March. Their total eggs for January and February numbered only 99.

In the case of poultry kept on the colony system there is no means of ascertaining the laying qualities of individual fowls. The total of the flock is known, but not of the individuals of which the flock consists.

Trap-nesting provides the only effectual way of eliminating the unprofitable, and breeding from the most prolific layers. The trap-nesting experiment that I am myself conducting for the Governors is restricted owing to want of room. It began on 1st March, and at the end of nine months—30th November—the number of eggs laid by each of eight hens was 114, 136, 71, 139, 117, 96, 142, 141. It will be seen that considerable diversity exists, although all are fowls of the same strain. The trap-nest is needed, not only to found a strain, but to preserve and improve it subsequently.

Should the fowls that I am trap-nesting continue at this rate to the close of the twelve months, these numbers would represent 152, 181, 94, 185, 156, 128, 189, 188—an average of 159 eggs. My intention is to mate up those that lay 170 eggs, and over, with a male bird, pedigree-bred from the best available laying strain, and from this mating to found a race of pedigree layers.

I am satisfied that there will be but little extension of, or enthusiasm in, poultry-keeping in Scotland until every district has its right kind of fowls: either such as give the largest return of good-sized eggs, or such as best serve for table purposes. It will avail but little to teach how poultry are to be fed and housed unless they inherit the qualities that give them value. These qualities can be effectively secured by establishing and supervising Breeding Centres such as are recommended in the report of the Departmental Committee on Poultry-Breeding in Scotland. An essential feature of all such centres is the use of the trap-nest in the case of laying breeds.

This system has been in operation in Denmark and Ireland for years past, and it has contributed largely to the prosperity of the poultry industry in both countries. It is at present in course of being established under the Con-

gested Districts Board, a commencement having been made in Orkney.

In the letter accompanying Mr. Murray's gift regard is had for the class of poultry-keeper most needing help—the cottar. This class will be reached. and all other classes also, by adapting the teaching in rural schools to the needs of the bulk of pupils. An infant teacher, provided with a half-dozen eggs of different size and differing in colour, and having at command a blackboard and coloured chalks, has all the equipment requisite to instruct, interest, and even charm a class of infants on the first day of their admission to school. With the simple equipment mentioned, it is easily possible to give a series of lessons fitted to awake the faculty of observation, and to convey a fairly accurate conception of form and colour. It were a simple matter to draft a scheme of lessons bearing upon the poultry-yard, and graduated to the capacity of scholars from the infant stage up to the closing day of school life. Whilst the course would be distinctly educational, it could not be otherwise than helpful in the practical poultry-keeping of later years. Besides, it is impossible to instruct the young in the principles that underlie what is best in the tillage of the fields, the cultivation of the garden, and the care and management of the poultry-yard, without the knowledge imparted in the school being discussed in the home. By interesting and instructing the children in what bears upon home life. not only the interest and instruction of parents are secured, but also their gratitude.

The rural school is not confined to the village. It is within reach of the dweller in the remote Highland glen. The time has surely come when rural school education should be localised, and adapted to the present and future needs of individuals generally. It is thus that the resources of the country will be developed and all classes benefited. Once the rural teacher, fully equipped, undertakes the instruction and training of the future poultry-keeper, the dawn of a long bright day breaks. There will be but short time to wait

until the seed-time of school life develops a remunerative harvest.

I cannot conclude without expressing deep obligations and sincere thanks to those who, with painstaking care, conducted the experiments, and I desire gratefully to acknowledge my indebtedness to Mr. Hendry.

I am, Gentlemen,

Your obedient servant,

WM. KEYS.

Colony No. 1. **WHITE WYANDOTTES.** **Mr. Gerrard, Greenmyre, Tarves.**

1908-09. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally. (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food.		
							(1)	(2)	(3)
Dec. -		None.	...	...	...	...	...	...	...
Jan. - -	Ten,	94	9/8	9/8	13/8½	5/9	3/11	3/11	7/11½
Feb. - -	including	120	10/4½	10/4½	15/-	2/8	7/8½	7/8½	12/4
Mar. -	Cockerel.	143	9/0½	9/0½	12/9	3/6	5/6½	5/6½	9/3
April -		204	17/6	12/10	14/10½	1/-	16/6	11/10	13/10½
May - -	All	180	17/3½	10/3½	13/9	1/7	15/8½	8/8½	12/2
June - -	hatched	175	9/11½	9/11½	14/7	5/5	4/6½	4/6½	9/2
July - -	in	154	9/7½	9/7½	12/10	4/6	5/1½	5/1½	8/4
Aug. - -	1908.	142	10/4	10/4	13/7½	3/-	7/4	7/4	10/7½
Sept. - -		132	11/-	11/-	14/7	1/-	10/-	10/-	13/7
Oct. - -		123	11/11	11/11	17/7½	/6	11/5	11/5	17/1½
Nov. - -		65	6/7½	6/7½	8/10	3/7	3/0½	3/0½	5/3
Totals, - -		1,532	£6 3 4	£5 11 8	£7 12 2	£1 12 6	£4 10 10	£3 19 2	£5 19 8

Average 170·2 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. The fowls were late in being hatched, and did not commence to lay until 2nd January.

2. The price "received" for eggs includes *extra* price charged for those sold for hatching purposes. This applies to all the colonies. Such eggs were usually sold for 3/6 a dozen.

3. Eggs not sold for hatching purposes were sold *locally*, as in column (2) above, and the excess of such price over cost of food is given above in the column to the right marked (2).

4. No eggs in this colony were sold at Aberdeen price. The price they would command in Aberdeen is shown in column (3) above. This is given for comparison of prices. The eggs of colony 3 were sold in Aberdeen, and are the basis for calculating "Price in Aberdeen."

5. Food.—Morning: A mixture of sharps, bruised oats, draff, bone meal. A little fat added in winter. Morning meal discontinued when natural food was plentiful. Evening: Usually oats, occasionally maize; shells, grit, and water always within reach.

Colony No. 2. **WHITE WYANDOTTES.** Mr. Anderson, Fingask House, Oldmeldrum.

1908-9. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally. (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food.		
							(1)	(2)	(3)
Dec. - -		163	18/3	18/3	27/2	5/-	13/3	13/3	22/2
Jan. - -	Ten,	68	7/-	7/-	9/11	4/6	2/6	2/6	5/5
Feb. - -	including	93	20/9	...	11/7	5/-	15/9	...	6/7
Mar. -	Cockerel.	158	37/4½	...	14/1	4/-	33/4½	...	10/1
April -		175	50/2	...	12/9	4/-	46/2	...	8/9
May - -	All	165	23/7	...	12/7	3/-	20/7	...	9/7
June - -	hatched	130	14/7	...	10/10	5/-	9/7	...	5/10
July - -	in	123	9/9	...	10/3	3/-	6/9	...	7/3
Aug. -	1908.	124	11/9	...	11/9	3/6	8/3	...	8/3
Sept.		130	15/-	...	15/-	3/6	11/6	...	11/6
Oct. - -		126	16/5	...	16/5	3/-	13/5	...	13/5
Nov. - -		125	19/-	...	19/-	5/-	14/-	...	14/-
Totals, - -		1,580	£12 3 7½	...	£8 11 4	£2 8 6	£9 15 1½	...	£6 2 10

Average 175·5 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. The "Price Locally" cannot be completed as part of the eggs were sold at local rate and part at Aberdeen rate.

2. The parent fowls of Colonies 1 and 2 were obtained from a breeder who traps nests and breeds from selected layers only. It is somewhat singular that the mother hens of Colony No. 2 averaged 175 eggs each last year. I examined their records, which were kept with great care by the party in charge.

3. Food.—Morning: Soft food prepared with boiling water and consisting of fine sharps, bruised oats or oat dust, brown sharps, household scraps. Evening: Good whole oats.

Colony No. 3. **WHITE WYANDOTTES.** Mr. Deans, Fornet, Skene.

1908-09. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally. (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food. (1)	(2)	(3)
Dec. -		123	20/6	...	20/6	3/4	17/2	...	17/2
Jan. - -	Ten,	78	11/4½	...	11/4½	3/-	8/4½	...	8/4½
Feb. - -	including	148	18/6	...	18/6	3/-	15/6	...	15/6
Mar. -	Cockerel.	143	17/9	...	12/9	3/-	14/9	...	9/9
April -		156	11/4½	...	11/4½	3/6	7/10½	...	7/10½
May - -	All	134	15/5	...	10/3	4/-	11/5	...	6/3
June - -	hatched	122	10/2	...	10/2	3/-	7/2	...	7/2
July - -	in	107	8/11	...	8/11	3/6	5/5	...	5/5
Aug. - -	1908.	130	12/6	...	12/6	2/10	9/8	...	9/8
Sept. - -		152	16/10	...	16/10	3/5	13/5	...	13/5
Oct. - -		65	9/4	...	9/4	3/6	5/10	...	5/10
Nov. - -		85	14/2	...	14/2	3/4	10/10	...	10/10
Totals, - -		1,443	£8 6 10	...	£7 16 8	£1 19 5	£6 7 5	...	£5 17 3

Average 160·3 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. The fowls comprising this colony were located on a high-lying farm. Considering their exposed surroundings they have given an excellent account of themselves. With the view of stocking the farm with their progeny, eggs during the hatching season were for the most part set, not sold.

2. The eggs throughout the year were sold in Aberdeen at best new-laid egg rates. In working out the "Price in Aberdeen" for eggs sold *locally*, the price of the eggs of Colony No. 3 were taken as the basis of calculation. This applies to Colonies No. 1, 2, 4, 5, 7, 8, 9. The cost of carriage of such eggs into Aberdeen is not reckoned.

3. Food.—Morning: Ground or bruised oats, sharps, mixed meals. Meat scraps added in winter, The whole cooked. Evening: Good oats. Skim milk given frequently.

Colony No. 4. **WHITE WYANDOTTES.** **Mrs. Law, Schoolhouse, Maud.**

1908-09. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally. (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food (1)	(2)	(3)
Dec. -		147	16/8½	16/8½	24/6	4/7	12/1½	12/1½	19/11
Jan. - -	Ten,	120	11/-	11/-	17/6	4/-	7/-	7/-	13/6
Feb. - -	including	148	24/6	11/2	18/6	4/3	20/3	6/11	14/3
Mar. -	Cockerel.	155	25/2	9/8½	13/9½	4/3	20/11	5/5½	9/6½
April -		147	42/-	7/7½	10/8½	4/-	38/-	3/7½	6/8½
May - -	All	158	26/6	8/2½	12/1	4/-	22/6	4/2½	8/1
June - -	hatched	140	8/2	8/2	11/8	5/-	3/2	3/2	6/8
July - -	in	122	7/6	7/6	10/2	5/-	2/6	2/6	5/2
Aug. - -	1908.	102	7/1	7/1	9/9½	4/6	2/7	2/7	5/3½
Sept. - -		91	7/7	7/7	10/0½	4/3	3/4	3/4	5/9½
Oct. - -		112	11/4	11/4	16/0½	5/-	6/4	6/4	11/0½
Nov. - -		72	8/5	8/5	12/-	5/	3/5	3/5	7 -
Totals, - -		1,514	£9 15 11½	£5 14 6	£8 6 9½	£2 13 10	£7 2 1½	£3 0 8	£5 12 11½

Average 168·2 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. This is one of the two flocks restricted in their range. A glance at the number of eggs, monthly, shows that some of them at least continued to lay during the moulting period. This applies to all the Wyandottes. It is otherwise with the Leghorns. See Colonies Nos. 7 and 8.

2. Observation brought out the persistent laying qualities of one hen in particular. The intention is to breed from her exclusively next season.

3. Food.—Morning: Ground oats, bran or sharps, pea meal in small quantities. The mixed meals cooked. Whole oats formed the morning food of hatching season. Evening: whole oats chiefly; maize occasionally.

Colony No. 5. **WHITE WYANDOTTES.** **Mrs. Strachan, Cardenwell, Fyvie.**

1908-09. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food. (1)	(2)	(3)
Dec. -		106	12/4½	12/4½	17/8	3/-	9/4½	9/4½	14/8
Jan. - -	Ten,	96	9/8	9/8	14/-	3/9	5/11	5/11	10/3
Feb. - -	including	105	21/1½	9/3	13/1	3/8	17/5½	5/7	9/5
Mar. -	Cockerel.	148	43/2	9/3	13/2	3/3	39/11	6/-	9/11
April -		222	64/9	11/6	16/2	2/10	61/11	8/8	13/4
May - -	All	174	50/9	9/0½	13/3½	2/8	48/1	6/4½	10/7½
June -	hatched	117	19/2	6/1	9/9	2/7	16/7	3/6	7/2
July - -	in	81	4/10	4/10	6/9	3/2	1/8	1/8	3/7
Aug. - -	1908.	108	8/-	8/-	10/4½	3/-	5/-	5/-	7/4½
Sept. -		132	11/-	11/-	14/7	2/9	8/3	8/3	11/10
Oct. - -		132	12/10	12/10	18/11	2/7	10/3	10/3	16/4
Nov. - -		51	6/9	6/9	8/6	3/4	3/5	3/5	5/2
Totals, - -		1,472	£13 4 5	£5 10 7	£7 16 3	£1 16 7	£11 7 10	£3 14 0	£5 19 8

Average 163·5 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. This colony was located in three different fields during the year. They had the advantage of proximity to land under cultivation and kept in close touch with the ploughshare and the harrows. They had the run of stubble land at the close of the harvest. They have given excellent results at small outlay.

2. In September and October the fowls had for their morning meal soft warm food, composed of a mixture of sharps, bran, and barley meal. This was the only food supplied, except shell and grit. All else they procured for themselves from the stubble land.

3. Food.—Morning: The materials consisted of sharps, bruised oats, bran or barley meal, prepared with boiling water. Evening: Good whole oats chiefly, varied occasionally with barley or maize. Skim milk given at times in lieu of water.

Colony No. 6. **WHITE WYANDOTTES.** Miss M. E. Macqueen, Fae-me-well, Cothal.

1908-09. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally. (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food. (1)	(2)	(3)
Dec. -		104	16/10½	...	16/10½	3/8	13/2½	...	13/2½
Jan. - -	Ten,	135	21/11½	...	21/11½	3/6½	18/5	...	18/5
Feb. - -	including	137	17/10½	...	17/10½	3/2	14/8½	...	14/8½
Mar. -	Cockerel.	153	29/4	...	13/9	3/3½	26/0½	...	10/5½
April -		172	29/2	...	12/6½	3/2	26/-	...	9/4½
May - -	All	142	15/9	...	10/10	2/11	12/10	...	7/11
June - -	hatched	131	10/11	...	10/11	2/5½	8/5½	...	8/5½
July - -	in	117	12/4	...	9/10	3/6	8/10	...	6/4
Aug. - -	1908.	118	11/1	...	11/1	3/8	7/5	...	7/5
Sept. -		71	6/7½	...	6/7½	3/9½	2/10	...	2/10
Oct. - -		40	5/2	...	5/2	3/1½	2/0½	...	2/0½
Nov. -		35	5/6	...	5/6	3/5	2/1	...	2/1
Totals, - -		1,355	£9 2 7	...	£7 2 11½	£1 19 8½	£7 2 10½	...	£5 3 3

Average 150·5 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. This is the other of the two flocks partly restricted in their range. It will be seen that both flocks kept in partial confinement have done remarkably well. At the end of the ninth month they had the lead in number of eggs.

2. The falling-off in the number of eggs in the three cloisng months is in some measure to be accounted for by a limitation of their wonted measure of freedom. They have kept in the best of health, and have had considerable attention given to their management and feeding.

3. Food.—Morning: Equal parts of maize meal, sharps, and ground oats, half part of bran, cooked and given warm—not hot. Evening: Oats and barley alternately. Green cut bone on alternate days. The materials slightly changed at intervals to give variety.

Colony No. 7. **WHITE LEGHORNS.** Mr. Anderson, Fingask House, Oldmeldrum.

1908-09. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally. (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food. (1)	(2)	(3)
Dec. -		113	12/8	12/8	18/-	5/-	7/8	...	13/-
Jan. - -	Ten,	120	11/11	11/11	17/6	4/6	7/5	...	13/-
Feb. - -	including	153	25/8	...	19/0½	5/-	20/8	...	14/0½
Mar. -	Cockerel.	175	19/10	...	15/7	4/-	15/10	...	11/7
April -		199	19/9½	...	14/6	4/-	15/9½	...	10/6
May - -	All	183	18/6½	...	14/-	4/-	14/6½	...	10/-
June - -	hatched	153	16/8	...	12/9	5/-		...	
July - -	in	84	6/9	...	7/-	3/-		...	
Aug. - -	1908.	41	3/8	...	3/11	3/6	6/3	...	2/10
Sept. -		6	/8	...	/8	3/6		...	
Oct. - -		None.	...	...	...	3/-		...	
Nov. - -		9	1/6	...	1/6	5/-		...	
Totals - -		1,236	£6 17 8	...	£6 4 5½	£2 9 6	£4 8 2	...	£3 14 11½

Average 137·3 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. This, one of the two colonies of White Leghorns, showed a very high average up to the end of June. The falling-off in the later months is attributable to the fowl naturally, and not to the character of its housing, feeding, and environment, for in these it shared the same as Colony No. 2. As the birds went into moult they discontinued laying, as did also the other Colony—Colony No. 8—of White Leghorns.

2. I am of opinion that on the White Leghorns becoming acclimatised the record here given will be improved. It is naturally wild, and would be more likely to be unfavourably influenced by changed conditions than would the Wyandotte.

3. Food.—Same as Colony No. 2.

Colony No. 8. **WHITE LEGHORNS.** **Mr. Wm. Carnie, Broomhill, Kintore.**

1908-09. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally. (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food. (1)	(2)	(3)
Dec. - -		75	9/4½	9/4½	12/6	4/4	5/0½	5/0½	8/2
Jan. - -	Ten,	50	5/5½	5/5½	7/3½	4/-	1/5½	1/5½	3/3½
Feb. - -	including	49	3/8	3/8	6/1	3/2	/6	/6	2/11
Mar. - -	Cockerel.	128	18/9	8/10½	11/4½	4/2	14/7	4/8½	7/2½
April -		150	22/6	7/7	10/11	4/4	18/2	3/3	6/7
May - -	All	172	20/1	9/6½	13/1½	3/8	16/5	5/10½	9/5½
June - -	hatched	163	11/10	11/10	13/7	4/6			
July - -	in	143	9/5	9/5	11/11	4/8			
Aug. - -	1908.	112	8/6	8/6	10/9	4/11	7/2½	7/2½	14/1½
Sept. - -		14	1/4	1/4	1/6½	3/5			
Oct. - -		None.	...	...	...	3/4			
Nov. - -		5	/7½	/7½	/10	3/8			
Totals, - -		1,061	£5 11 6½	£3 16 2½	£4 19 11	£2 8 2	£3 3 4½	£1 8 0½	£2 11 9

Average 117·7 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. This colony has occupied an exposed position throughout the year. I think it likely that better results will be obtained in future years when stock of moorland upbringing, with a life experience of our northern weather, are on farms such as this.

2. As cost of food exceeded price of eggs in the closing months of the year, the last six months are grouped in Colonies 7 and 8 in order to bring out the profits.

3. Food.—Morning: In January—one part ground oats, one part sharps, half part maize meal, half part meat meal. Cost 2/3. Evening: 36 lbs. oats. Cost 1/9. The food was varied slightly at intervals. Meat meal not given after spring set in.

Colony No. 9. **WHITE WYANDOTTES.** Mr. Thos. Middleton, Corntown, Conon Bridge.

1908-09. Month.	No. of Fowls.	No. of Eggs.	Price Received. (1)	Price Locally. (2)	Price in Aberdeen. (3)	Cost of Food.	Excess of Prices over Cost of Food. (1)	(2)	(3)
Dec. -		54	7/9	7/9	9/-	5/3	2/6	2/6	3/9
Jan. - -	Ten,	121	14/0½	14/0½	18/9	4/-	10/0½	10/0½	14/9
Feb. - -	including	117	9/3½	9/3½	14/7	3/10	5/5½	5/5½	10/9
Mar. -	Cockerel.	144	9/4½	9/4½	12/10	4/1	5/3½	5/3½	8/9
April -		152	11/2	11/2	11/1	3/10	7/4	7/4	7/3
May - -	All	120	17/10½	7/1	9/2	3/10	14/0½	3/3	5/4
June - -	hatched	123	8/5½	8/5½	10/3	4/11	3/6½	3/6½	5/4
July - -	in	98	6/10	6/10	8/2	3/3	3/7	3/7	4/11
Aug. - -	1908.	75	8/8	8/8	7/2½	2/-	6/8	6/8	5/2½
Sept. - -		116	11/3½	11/3½	12/2	2/9	8/6½	8/6½	9/5
Oct. - -		84	9/5½	9/5½	12/0½	Nil.	9/5½	9/5½	12/0½
Nov. - -		33	4/2	4/2	5/6	3/-	1/2	1/2	2/6
Totals, - -		1,237	£5 18 4½	£5 7 7	£6 10 9	£2 0 9	£3 17 7½	£3 6 10	£4 10 0

Average 137·4 eggs per hen for year ended 30th November, 1909.

REMARKS.—1. The birds forming this colony were hatched too late in the season to do themselves justice in a competition. By feeding on stimulating food they were brought on to lay sooner than they would otherwise have done. I take it that this is a reason for the eggs being under standard size in the early part of the year.

2. The size of eggs varies with the age of the fowls, with the character of their food, and with the strain or family.

3. Food.—Morning: Materials—equal parts of bruised oats, bruised barley, and sharps; also a little meat meal in winter and early spring. Evening: Whole oats chiefly; barley occasionally.